SCIENCE

JUNE 2, 1950

Copy

TEACHING OF SCIENCE AT THE COLLEGE LEVEL

FERNANDUS PAYNE

THE ROLE OF THE TIME FACTOR IN PROTEIN SYNTHESIS

ERNEST GEIGER

TECHNICAL PAPERS

ASSOCIATION AFFAIRS

SCIENTIFIC BOOK REGISTER

NEWS AND NOTES

COMPLETE TABLE OF CONTENTS ON PAGE 3

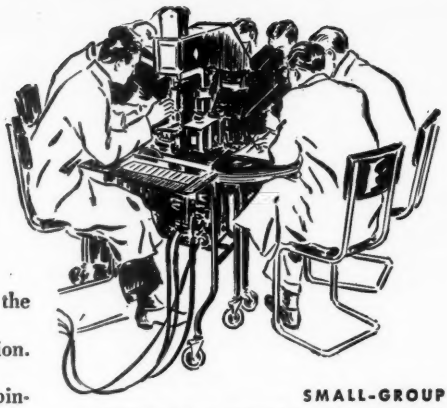
VOLUME 111, NUMBER 2892

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

for example

...in cancer case study

The high-pressure mercury arc of the Scopicon is the brightest light source ever employed for microprojection. The focal spot employed is roughly 1 mm. square: its pinpoint character permits flickerless projection of crisply detailed images up to ten feet across *even under oil-immersed microscope objectives*. The white color exhibits the various biological stains to splendid advantage May we send you the brochure describing this versatile new instrument?



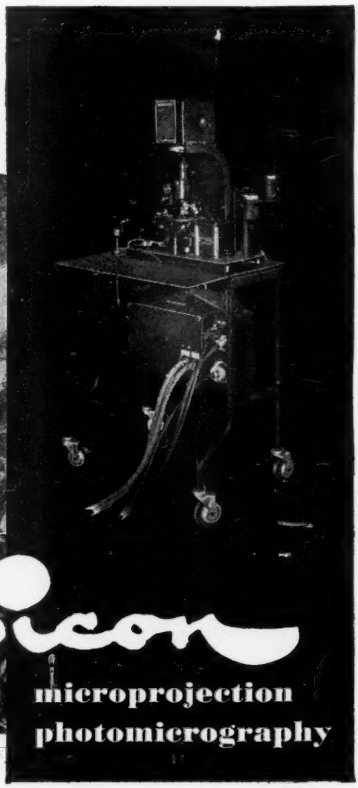
SMALL-GROUP STUDY IN A NORMALLY LIT ROOM

Image is cast in a dark-chamber table height screen: each observer has a separate light-excluding viewing hood.

SCOPICON, Inc.
215 East 149 Street
New York 51, N.Y.

MASS DEMONSTRATIONS IN THE AUDITORIUM

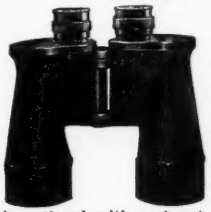
The projectionist can follow a specimen through a progressive series of ever-closer localizations, from its gross aspect to its ultimate microscopic demonstration under oil-immersed objectives.



BARGAINS in WAR SURPLUS OPTICS

ASSEMBLE YOUR OWN BINOCULARS!

Complete Optics! Complete Metal Parts! Save More Than ½ Regular Cost



GOVT. 7 x 50 BINOCULARS

Here's an unusual opportunity to secure a fine set of Binoculars at a substantial saving of money. Offered here are complete sets of Optics and Metal Parts for the 7 x 50 Binoculars. These components are new and all ready for assembly. We supply full instructions.

METAL PARTS—Set includes all Metal Parts—completely finished—for assembly of 7 x 50 Binoculars. No machining required. A sturdy Binocular Carrying Case is optional with each set of Metal Parts.

Stock #842-W ..... **$39.40 Postpaid.**
plus $4.80 for Case—**Total $44.20**

OPTICS—Set includes all Lenses and Prisms you need for assembling 7 x 50 Binoculars. These Optics are in excellent condition—perfect or near perfect—and have new low reflection coating.

Stock #5102-W ..... **7 x 50 Optics** ..... **$25.00 Postpaid**
(These are standard American-made parts . . . not Japanese)
NOTICE: Add 20% Federal Excise Tax if you buy both Binocular Optics and Metal Parts.

SPECIAL! SPECIAL! RONCHI RULINGS

BLACK LINE GRATING

Plate glass with etched parallel black lines—space between each line is same as thickness of the ruled line itself. Number of lines per inch range from 65 to 133 as shown below. Used for testing astronomical mirrors, testing microscope objectives and magnifiers, used in pairs to see diffraction pattern.

1 in. x 1 in.			2 in. x 2 in.		
Stock No.	Lines Per In.	Price	Stock No.	Lines Per In.	Price
2122-W	65	$ .75	2133-W	65	$1.50
2126-W	85	.75	2134-W	85	1.50
2127-W	110	1.00	2136-W	110	2.00
2128-W	120	1.00	2137-W	120	2.00
2129-W	133	1.00	2138-W	133	2.00

All above sent Postpaid.

SEE COLOR TELEVISION NOW! TODAY! . . . for only $1.00

See your Black and White image in vivid colors. Your optical "converter" is one of our Plain Tank Prisms. Simply hold it up to your eyes and look through the prism. Your television image will take on brilliant hues of red, orange, yellow, blue, green, indigo, violet. A beautiful sight! Practical? Not for steady use, but definitely a unique and novel effect. These prisms are war surplus . . . sold at a fraction of their original cost.

Stock #3101-W—Plain Tank Prism (Seconds—Slightly chipped) .. **$1.00 Pstpd.**
Stock #3005-W—Plain Tank Prism (First Class) **$2.00 Pstpd.**

RIGHT ANGLE PRISMS

Stock #3122-W .... 6 mm. x 6 mm. Face .... **$ .80 Pstpd.**
Stock #3131-W .... 11 mm. x 13 mm. Face .... **$1.00 Pstpd.**
Stock #3145-W .... 20 mm. x 19 mm. Face .... **$1.00 Pstpd.**
Stock #3162-W .... 25 mm. x 25 mm. Face .... **$1.50 Pstpd.**
Stock #3155-W .... 31 mm. x 31 mm. Face .... **$3.00 Pstpd.**
Stock #3102-W .... 32 mm. x 33 mm. Face .... **$1.00 Pstpd.**
Stock #3169-W .... 41 mm. x 40 mm. Face .... **$3.00 Pstpd.**
Stock #3091-W .... 47 mm. x 47 mm. Face .... **$4.00 Pstpd.**
Stock #3054-W ... 167 mm. x 49 mm. Face .... **$4.00 Pstpd.**

8 POWER ELBOW TELESCOPE

Gov't Cost $200.00! Our Price $27.50!

Big 2" diameter objective. All lenses Achromatic. Amici prism erects the image. 4 built-in filters—clear, amber, neutral and red. Slightly used condition but all guaranteed for perfect working order. Weight 5 lbs. Can be carried but a trifle bulky. Excellent for finder on Astronomical Telescope.

Stock #943-W ..... **$27.50 Postpaid**

MOUNTED PROJECTING LENS SYSTEM

F.L. 91.44 mm. (just right for 35 mm. Projectors). Speed of F. 1.9. Outside dia. of mount at one end 60 mm. Length of mount 64 mm.

Stock #4033-W ..... **$3.00 Postpaid**

SIMPLE LENS KITS! — THE LENS CRAFTERS DELIGHT! Fun for adults! Fun for children! Kits include plainly written illustrated booklet showing how you can build lots of optical items. Use these lenses in photography for copying. **ULTRA CLOSE-UP SHOTS,** Microphotography, for "Dummy Camera", Kodachrome Viewer, Detachable Reflex View Finder for 35 mm. cameras. Stereoscopic Viewer, ground glass and enlarging focusing aids. And for dozens of other uses in experimental optics, building **TELESCOPES,** low power Microscopes, etc.

Stock #2-W—10 lenses ..... **$ 1.00 Postpaid**
Stock #5-W—45 lenses ..... **$ 5.00 Postpaid**
Stock #10-W—80 lenses ..... **$10.00 Postpaid**

THICK FIRST SURFACE MIRROR—Aluminized and hard coated. May be cleaned without scratching surface. Optically flat to ¼ wave. Size 3-13/16" x 3-3/16" . . 9/16" thick. Excellent substitute for large Right Angle Prism.

Stock #562-W ..... **$3.00 Postpaid**

TELESCOPE EYE-PIECE—Consists of 2 Achromatic Lenses. F.L. 28mm. in a metal mount.

Stock #5140-W ..... **$4.50 Postpaid**

LOOK! LOOK! LOOK!

Sheet Polarizing Material—
Stock #691-W ..... Pair of 1" dia. Circles ..... **20¢ Pstpd.**
Stock #692-W ..... Pair of 2" dia. Circles ..... **35¢ Pstpd.**

CONDENSING LENSES—Seconds, but suitable for Enlargers and Spotlights.

Stock #1103-W ... 29/32" dia. ½" F.L. ... **$ .50 ea. Pstpd.**
Stock #1086-W ... 1 11/16" dia. 3" F.L. ... **$ .25 ea. Pstpd.**
Stock #1077-W .... 2⅜" dia. 3" F.L. .... **$1.00 ea. Pstpd.**
Stock #1084-W .... 2½" dia. 4" F.L. .... **$1.00 ea. Pstpd.**
Stock #1099-W ... 4 7/16" dia. 6½" F.L. ... **$1.20 ea. Pstpd.**
Stock #1115-W ..... 2" dia. 3¼" F.L. ..... **$ .50 ea. Pstpd.**
Stock #1019-W ..... 6" dia. 16" F.L. ..... **$2.00 ea. Pstpd.**
Stock #1061-W ..... 6½" dia. 9" F.L. ..... **$2.50 ea. Pstpd.**

LENS CLEANING TISSUE—1st quality, sheet size 11" x 7½". Made to Govt. Specs. Free of abrasives. High wet strength.

Stock #721-W ..... 500 sheets ..... **$1.00 Postpaid**

SLIDE PROJECTOR SETS—Consist of all unmounted lenses you need to make the following size projectors:

Stock #4038-W ..... 2¼" x 2¼" ..... **$3.35 Postpaid**
Stock #4039-W ..... 2½" x 3½" ..... **$3.35 Postpaid**
Stock #4035-W ..... 35 mm. ..... **$4.85 Postpaid**

MOUNTED TELESCOPE EYE-PIECE—Kellner type. Excellent astronomical and other telescopes. War Surplus. Government cost about $18.00. Focal length 24 mms. Lens Diameter 23 mms. Unusually wide field.

Stock #5189-W ..... **$3.25 Postpaid**

TERRIFIC BARGAIN! BUBBLE SEXTANT

BRAND NEW and with Automatic Electric Averaging Device and Illuminated Averaging Disc for nighttime use. Govt. cost $217. Though brand new, we have re-checked Bubble and Collimation and guarantee perfect working order.

Stock #933-W .. **$22.50 Postpaid**

IF YOU'RE INTERESTED IN OPTICAL BARGAINS
Write for FREE CATALOG W
We Have Literally Millions of War Surplus Lenses and Prisms for Sale at Bargain Prices. Numerous Types of Instruments Too!
ORDER BY SET OR STOCK NO.
EDMUND SALVAGE COMPANY · BARRINGTON, NEW JERSEY

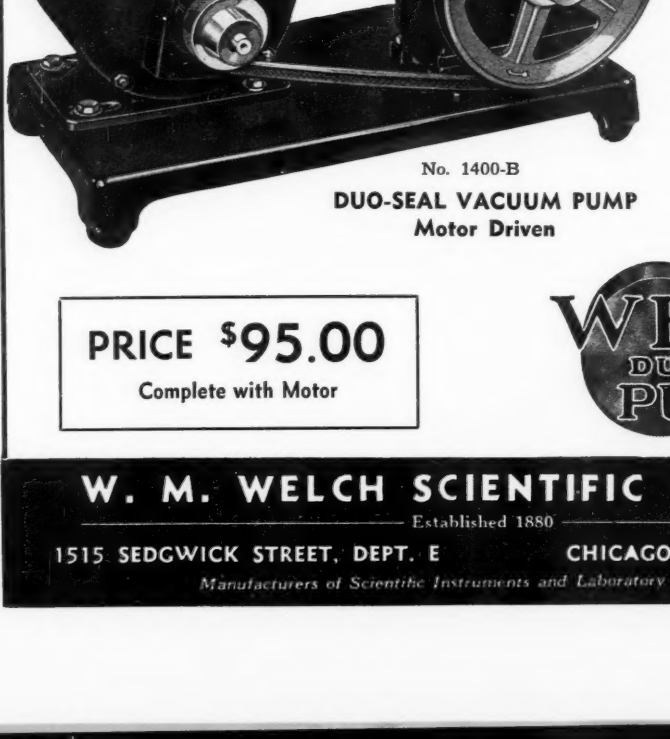
Weeks of running in and periodic testing assures greater durability

Welch Duo-Seal Vacuum Pumps

HIGH VACUUM 1/10 Micron GUARANTEED

FREE AIR CAPACITY 21 Liters Per Minute

- DEPENDABLE
- ECONOMICAL
- EFFICIENT
- STURDY



No. 1400-B

DUO-SEAL VACUUM PUMP
Motor Driven

Faster Pumping

Lowest Pressures

Silent Operation

Operating Speed 450 R.P.M.

IMMEDIATE SHIPMENT

PRICE $95.00
Complete with Motor

WELCH DUO SEAL PUMPS

W. M. WELCH SCIENTIFIC COMPANY
Established 1880
1515 SEDGWICK STREET, DEPT. E CHICAGO 10, ILLINOIS, U.S.A.
Manufacturers of Scientific Instruments and Laboratory Apparatus

SCIENCE

Vol. 111 No. 2892 Friday, June 2, 1950

AAAS EDITORIAL BOARD
(Terms Expire June 30, 1950)

George A. Baitsell — H. Bentley Glass
Karl Lark-Horovitz
Lorin J. Mullins — Malcolm H. Soule
Howard A. Meyerhoff
Chairman

Beth Wilson
Executive Editor of Science

F. A. Moulton, Advertising Representative

Table of Contents

Teaching of Science at the College Level: *Fernandus Payne* 589

The Role of the Time Factor in Protein Synthesis: *Ernest Geiger* 594

Technical Papers

Detoxification of DDT by Resistant Houseflies and Inhibition of This Process by Piperonyl Cyclonene: *A. S. Perry* and *W. M. Hoskins* 600

Biosynthesis of Radioactive Vitamin B_{12} Containing Cobalt 60: *Louis Chaiet, Charles Rosenblum,* and *David T. Woodbury* 601

Culturing *Crepidula plana* in Running Sea Water: *Harley N. Gould* 602

Egg Capsules of River Limpet Snails: Material for Experimental Biology: *Poul Bondesen* 603

Presence of Iodinated Amino Acids in Unhydrolyzed Thyroid and Plasma: *J. Gross* et al. 605

Xanthopterin Obtained from the Skins of the Yellow Mutant of *Bombyx mori* (Silkworm): *Y. Hirata, K. Nakanishi,* and *H. Kikkawa* 608

Processing Unit for 35-mm Color Film: *O. S. Gibbs* and *J. R. Wilder* 609

Growth Regulators Prolong the Bloom of Oriental Flowering Cherries and Dogwood: *Horace V. Wester* and *Paul C. Marth* 611

Association Affairs 612

Scientific Book Register 614

News and Notes 615

Science, a weekly journal founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Editorial and Advertising Offices, 1515 Massachusetts Ave., N.W., Washington 5, D. C. Telephone, Executive 6060. Cable address, SCIMAG, Washington, D. C. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P.L. & R. of 1948.

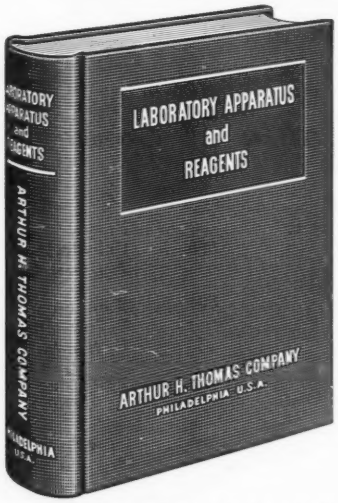
Manuscripts submitted for publication should be sent to the Editorial Office, with stamped, self-addressed envelope enclosed for possible return. The AAAS assumes no responsibility for the safety of the manuscripts or for the opinions expressed by contributors.

Annual subscription, $7.50; single copies, $.25; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, $.50. Remittances and orders for subscriptions and single copies should be sent to the Circulation Department, *Science,* 1515 Massachusetts Ave., N.W., Washington 5, D. C. Membership correspondence for the AAAS should be addressed to the Administrative Secretary at the same address.

Change of address. Four weeks' notice is required for change of address. This should be sent to Science Recorder, 1515 Massachusetts Ave., N.W., Washington 5, D. C. When ordering a change, it is necessary to furnish an address stencil label from a recent issue. Claims for a missing number will not be allowed if received more than 60 days from date of issue. No claims allowed from subscribers due to failure to notify the Circulation Department of a change of address or because an issue is missing from their files, or for any reason from subscribers in Central Europe, Asia, or the Pacific Islands (other than Hawaii).

The AAAS also publishes *The Scientific Monthly.* Subscription rates on request.

NEW EDITION
A. H. T. CO. CATALOGUE
NOW IN DISTRIBUTION



Facsimile of catalogue, size 8½ x 10¾ x 2½ inches.

The new 1472-page edition of our general catalogue LABORATORY APPARATUS AND REAGENTS illustrates and describes over 15,000 Apparatus items, together with 6,000 Reagent items, all selected primarily for use in laboratories of Chemistry and Biology. The many new items include a comprehensive assortment for use in Microchemistry.

In addition to a code word adjacent to each item—for economical ordering by teletype, telegraph or cable—the new edition includes net and shipping weights for convenience in estimating shipping charges, with particular reference to air service.

When requesting copies of this catalogue, scientists will greatly oblige us by a full statement as to their professional connection with organized laboratory work, and purchasing officers by information as to final disposition of the catalogue, i.e. in the purchasing office or in the laboratory.

We welcome suggestions from those in authority as to the number of catalogues required for convenient use in any laboratory, department, institution or establishment. Such cooperation aids us in making adequate distribution without unnecessary duplication.

ARTHUR H. THOMAS COMPANY
RETAIL—WHOLESALE—EXPORT
LABORATORY APPARATUS AND REAGENTS
WEST WASHINGTON SQUARE PHILADELPHIA 5, PA., U. S. A.
Cable Address, "BALANCE," Philadelphia

Your answer to the problem of nuclear demonstration

A complete outfit for demonstrating and teaching the fundamentals of radioactivity

● The new Nuclear Classmaster is the first adequate answer to the growing need for classroom and platform demonstration equipment to be used in teaching the fundamentals of radioactivity. While the operation of a Geiger counter can be shown with any count-rate or scaling instrument, the Classmaster is provided with accessories which permit demonstration and study of all of the nuclear phenomena normally covered in elementary instruction. It also permits many characteristics to be measured or calculated quantitatively.

The basic electronic instrument indicates each disintegration by a neon tube flash and an audible click. The rate of count is also shown plainly on a large easy-to-read meter. By the use of the calibrated mounting device and the absorbers and radioactive sources provided, a complete set of experiments can be performed or the apparatus used for simple demonstration. A twenty-eight page instruction manual describes these experiments, both elementary enough for high school classes and comprehensive enough for students on the college level.

The "Classmaster" is another of nuclear's wide range of instruments to meet the many requirements of nuclear science. Write for full details today!

nuclear INSTRUMENT & CHEMICAL CORPORATION

237 West Erie Street • Chicago 10, Illinois Cable Address: "Nuclear"

- Scaling Units for Every Type of Radiation Counting
- Complete "Packaged" Counting Systems
- Health Monitoring Instruments for Personnel Protection
- Glass Wall, Mica Window, and Windowless Counters
- Portable Count Rate Meters
- Complete Line of Accessories for the Nuclear Laboratory

nuclear "PRECISION INSTRUMENTATION FOR NUCLEAR MEASUREMENTS"

The SCIENTIFIC MONTHLY

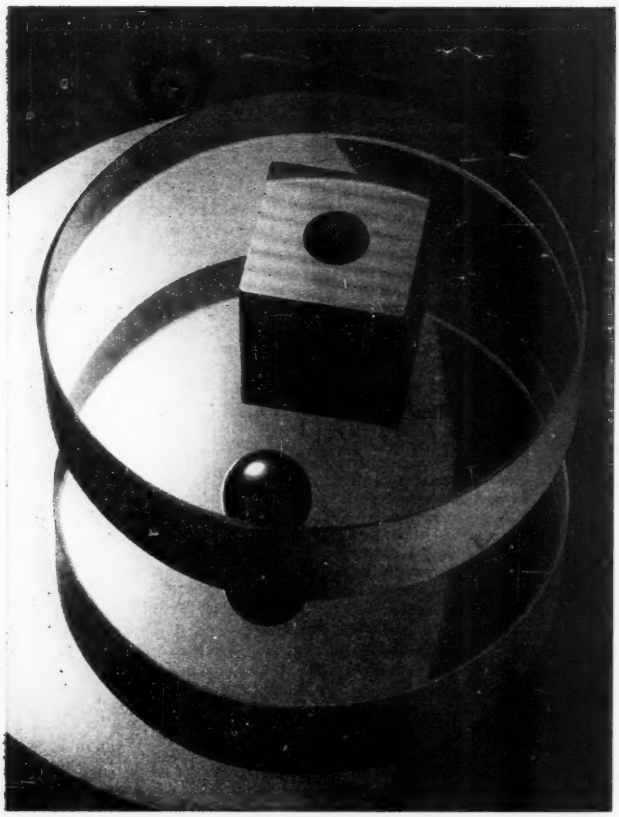
in cooperation with the

SMITHSONIAN INSTITUTION

announces the

4th ANNUAL INTERNATIONAL SALON

Photography in Science



Photograph from Third Salon
by Charles J. Salat
of Armour Research Foundation

ELIGIBILITY

Any scientist actively engaged in research (including photographic), teaching, private practice, or consulting work is eligible. All photographs must be taken for scientific purposes, and purely pictorial and hand-colored prints are not eligible.

DEADLINES

Entries will be received by The Editor, THE SCIENTIFIC MONTHLY, November 1 to 27, 1950. Prize winners will be notified on or before December 10, 1950.

AWARDS

First, second, and third awards and five honorable mentions will be given in each section. Suitable certificates will go to the winners.

CONDITIONS

Prints must be mounted on 16 x 20 inch mounts, carrying technical and other information, and be shipped prepaid. No entry fee is required. A total of 8 entries (each one numbered), 4 in color and 4 in black and white, may be submitted. All entries will be returned after being shown in this country and abroad.

For complete information and entry blanks, write to

The Editor, THE SCIENTIFIC MONTHLY
1515 Massachusetts Ave., N.W.
Washington 5, D. C.

for new horizons in

Photomicrography
& scientific photography
the Orthophot

Designed for the ultimate in versatility, the new Silge & Kuhne Orthophot provides all the facilities for photomicrography (using any standard microscope), photomacrography, microprojection, photocopying, microfilming, x-ray copying, enlarging, and general laboratory and scientific photography.

Orthophot set up for photomicrography with standard microscope. Built-in, permanently-aligned light source with complete color and intensity controls. Precision reflex camera has *split-micron* focusing device.

PHOTO-MACROGRAPHY

In seconds, Orthophot converts for photomacrography. Adjustable macro-stand replaces microscope. Same highly-controllable illumination and split-micron focusing used.

PHOTO REPRODUCTION

Black Bakelite table and oblique camera arm convert Orthophot to photocopy unit for gross specimens, drawings, photographs, papers, etc. Special table transilluminates.

ENLARGING

Substitution of enlarger head with opal-bulb light source and double condensing lens makes Orthophot into precision photoenlarger. Quick, needle-sharp focusing with illuminated target on table and using reflex mirror.

CINEMICROGRAPHY

Simplified column on Orthophot accommodates still cameras from miniatures to 4 by 5 Graflex types, almost all 8- and 16-mm cine cameras, and many 35-mm models. Extended adjustments provide alignment with standard microscopes.

MICROSCOPY

Separately, illustrated, or as part of complete Orthophot, Ortho-illuminator excels for routine microscopy, darkfield, and other research techniques, and *particularly* phase work. Near parallel beam of light, free from filament image, rises vertically from base, entering microscope condenser directly. Operation on a-c or d-c power.

Accessory units not shown include microprojection viewer with 8- by 8-in. vertical ground glass, alternative exposure meters approximately 20 and 2000 times as sensitive as standard commercial types, and bellows-extension adapters to increase magnification or establish fixed ratios.

This versatile equipment is supplied either in complete assemblies or in separate sections to coordinate with existing laboratory facilities. Write for descriptive data.

103 YEARS

See this equipment at the San Francisco Convention Booth N-35

Silge & Kuhne

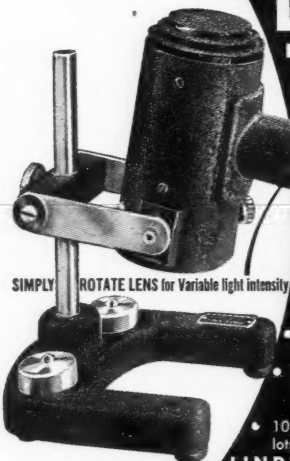
153 Kearny St. San Francisco 8, Calif.

Specialists in Microscopic and Photomicrographic Equipment

NEW bright LAMP of science

Already first on every order list. The universal all-purpose lamp for laboratory and research—a marvel of efficiency and economy.

LINDLY microscope LAMP



SIMPLY ROTATE LENS for Variable light intensity

- Standard projection bulb used.
- Daylight filter supplied with lamp.
- 2 lens condenser.
- Slides and Pivots to any position.
- Color filters and lens available for special purposes.
- 10% discount in lots of 5 or more.

$28.50

At your Dealer or write Dept S
Send for FREE Brochure

LINDLY & COMPANY
80 Herricks Rd., Mineola, N. Y.

AMINO ACIDS
for
Biological & Microbiological
INVESTIGATIONS

70
AMINO ACIDS

Write for Catalogue S #810—Spring Edition
— May 1950 —

Listing a Complete Selection of Over 400 Important Biochemicals

NUTRITIONAL BIOCHEMICALS CORP.
CLEVELAND 5, OHIO

YEAR AFTER YEAR YOU CAN DEPEND ON "UNIFORMULA" LABORATORY CHOW

Purina Laboratory Chow is made to give you uniformity of feeding results through several generations of laboratory animals. Today you can feed the same "uniformula" Purina Laboratory Chow . . . made from fine ingredients exactly in the same formula as it was last year and the years before. See your nearest Purina Dealer and begin today feeding constant, dependable Purina Laboratory Chow.

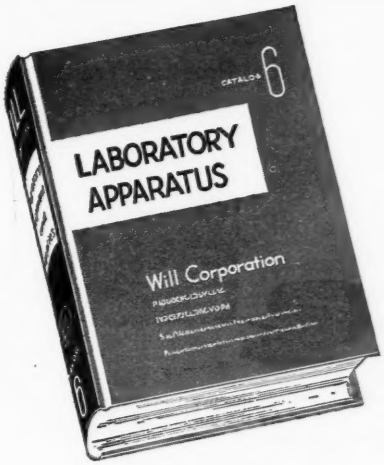
Ralston Purina Company
1704 Checkerboard Square
St. Louis 2, Missouri

Please send me your 28-page handbook on the care and feeding of laboratory animals (SP 4629).

Name.....

Address.....

City.....*State*.....



JUST PRINTED!

902 Pages
12,000 Items
3,500 Illustrations

Catalog No. 6

The newest, most complete, most up-to-date, easy-to-use catalog of quality Laboratory Apparatus, Equipment and Supplies. No industrial, medical and educational laboratory or research organization can be fully abreast of today's scientific equipment without this book on its shelves! Thousands of copies have been mailed to all prospective users whose names are known to us. If yours hasn't arrived and you would like this invaluable reference on your desk . . .

Simply Send a Request on your Business Letterhead, giving your name and title and the correct name and address of your organization.

Address your request to the nearest of our office-warehouses listed below.

• ATLANTA, GA.
SOUTHERN SCIENTIFIC CO.
• BUFFALO, N. Y.
BUFFALO APPARATUS CORP.

WILL
SERVING SCIENCE THROUGH SUPPLY

• NEW YORK, N. Y.
WILL CORPORATION
• ROCHESTER, N. Y.
WILL CORPORATION

TODAY'S TECHNIQUES + MOHAVE DESIGN = ACHIEVEMENT

NEW HASTINGS TRIPLET, 10X

Has a larger field, fullest correction—ruggedly built with stainless steel frame to withstand roughest field usage. In use by every branch of Science where an accurate, trustworthy lens is a requisite. You will apprcciate its better optical performance.

$12.00 in U.S.A.

MINERAL TEST SET - MOH'S HARDNESS

- 9 Standard Minerals
- Alnico V chisel magnet
- Mohave ¼ in. streak plate in sturdy box with Moh's scale

Economical, Easy & Convenient to use, Conserves Precious Time—The investment students respect.

$2.00 list

POCKET STEREOSCOPE

$10.00 in U.S.A.

Folding stereo in sturdy leather case —Indispensible in field or laboratory. Maximum depth-of-focus, stereo effect, for physiographic and cartographic detail. Priced for the student budget—built for professional practice!

DISTRIBUTORS

B. K. Elliott Co., Pittsburgh—Cleveland—Detroit. Kinsman Optical Co., Washington 4, D. C. Clay Adams Co., New York 10, N. Y. Petroleum Ind. Consultants, Apart. 1953, Caracas, Venezuela, S.A. Geol. Eng. Consultants, Havana, Cuba.

FACTORY REPRESENTATIVES

Wilson Sales, Sta. A—Flushing, N. Y. O. L. Cluck, 202 So. 10th St., Minneapolis 2, Minnesota.

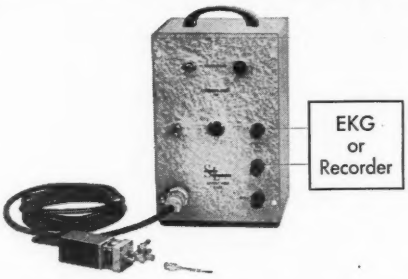
Factory shipments if out of stock—Dept. 16

STRATEX INSTRUMENT CO. Mfrs. of Engrs. for SCIENTISTS

1861 HILLHURST AVE., LOS ANGELES 27, CALIF. U.S.A.

STATHAM

Physiological Pressure Transducers



The Model P23 pressure transducers were specifically designed for the purpose of measuring and recording arterial and venous blood pressures. The system illustrated above demonstrates how simply measurements can be obatined with Statham transducers.

Please write our Engineering Department for more specific data.

STATHAM LABORATORIES

SCIENTIFIC INSTRUMENTS

9328 Santa Monica Blvd., Beverly Hills, Calif.

"VACSEAL"

MEANS DEPENDABILITY IN GUINEA PIG COMPLEMENT

Since 1939, Carworth Farms has been the largest producer of guinea pig complement in this country. We are now distributing this material under our own label, "Vacseal", at a more favorable price.

It is well known that the production of this biologic requires great care. Our long experience and large output enable us to offer a superior product to the laboratory worker. We invite you to try "Vacseal" Guinea Pig Complement, available in glass ampules with a special diluent for restoration to the following amounts:

3 cc 7 cc 20 cc

Any recognized laboratory will receive a trial 3 cc package on request.

CARWORTH FARMS INC

NEW CITY · ROCKLAND COUNTY · NEW YORK

New McGRAW-HILL Books

INTRODUCTION TO AMERICAN FORESTRY. New 2nd Edition

By SHIRLEY W. ALLEN, University of Michigan. *American Forestry Series.* Ready for fall classes

A revision of a well-known college text, brought fully up to date, with new material on forest policy, forest-planting, methods of fire, insect, and disease control, mechanization of logging and other timber harvesting, and state and national forestry planning.

INTRODUCTION TO ELECTRICITY AND OPTICS. New 2nd Edition

By N. H. FRANK, Massachusetts Institute of Technology. Ready for fall classes

A revision and enlargement of this successful intermediary text; the primary purpose of this edition is to expand and improve where necessary the physical principles and thinking underlying the subject. Although demanding only a knowledge of elementary integral and differential calculus, the book challenges the student continuously in the application of this mathematical background to physical situations.

PHYSICAL CHEMISTRY FOR PREMEDICAL STUDENTS. New 2nd Edition

By JOHN P. AMSDEN, Dartmouth College. *International Chemical Series.* Ready for fall classes

Designed as a one-semester course for premedical students, and including those topics of elementary physical chemistry which will be of value in later professional work, the new edition of this successful text is fully up to date. A new chapter on *thermodynamics* will be of great assistance to the student in understanding chemical equilibrium and electrode and cell potential.

ELEMENTS OF HEALTHFUL LIVING. New 2nd Edition

By HAROLD S. DIEHL, M.D., University of Minnesota. Ready in June

A new revision of the abridgement of *Textbook of Healthful Living*, this edition offers new material on personal and community health, as well as an additional chapter on the care of the skin. Housing and health have been given more consideration and various proposals for the expansion and financing of medical and public health services and discussed.

A TEXTBOOK OF BIOCHEMISTRY. New 2nd Edition

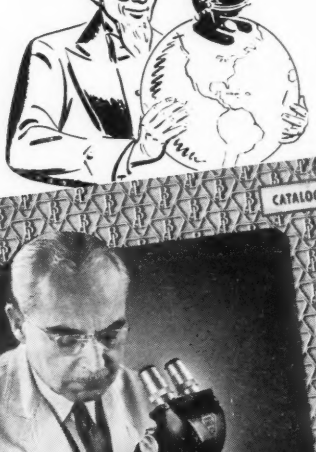
By PHILIP H. MITCHELL, Brown University. Ready for fall classes

A modernized and introductory presentation of the essentials of biochemistry, centering upon metabolism and human nutrition. Emphasis is given to the constitution and activity of enzymes, the intermediary reactions of anabolism and catabolism, and the vital significance of hormones and vitamins. The material is up to date and includes recent advances in the field.

Send for copies on approval

McGRAW-HILL BOOK COMPANY, INC.

330 WEST 42ND STREET, NEW YORK 18, N. Y.



Bausch & Lomb *Proves Again*

America's Optical Leadership!

That is the enthusiastic response of many leading microscopists to the new Bausch & Lomb Series E Research Microscopes . . . after they checked the specifications in this new catalog . . . and tested the performance of these fine new research instruments in actual demonstrations. You'll be convinced, too, by . . .

New IMPROVED IMAGE QUALITY!

New Conveniences! *New* Accuracy! *New* Construction!

Top image quality from improved apochromatic objectives and BALCOTED optical system . . . important conveniences such as *lower* fine adjustment . . . quickly interchangeable binocular body and monocular tube . . . and integral mechanical stages with longer length of travel and greater slide area.

New high accuracy from improved precision-built mechanical stages . . patented ball-bearing fine adjustment . . . and substage condenser with slow-motion focusing adjustment.

New construction gives you a sturdy, well-balanced stand . . . solid stability for steady operating ease.

Write for your demonstration and catalog to Bausch & Lomb Optical Co., 642-X St. Paul Street, Rochester 2, N. Y.

BAUSCH & LOMB *Series E* RESEARCH MICROSCOPES

Teaching of Science at the College Level[1]

Fernandus Payne
Indiana University, Bloomington

TEACHING PROBLEMS in one form or another are as old as man himself. The problems vary, however, from time to time with advances in knowledge and ever changing conditions and, because of the variables, will never be solved. Like the rainbow, they recede as we approach solutions. Hence continuous study is necessary. I write as an individual with a background of varied experiences, including that of student, teacher, and administrator, each of which has had greater or lesser influence on my thinking. I have reached certain tentative conclusions but am willing to modify those conclusions in the light of convincing evidence. I am not willing, however, to accept unchallenged every new educational movement that presumes to cure all our ills. The fact that there is so much discussion today of teaching of science at the college level implies criticism of present procedures. On the other hand, the implication may be simply that a good teacher is never satisfied with what he does and is always looking for ways and means of doing a better job. If we are critical, what are the criticisms? Are they just, supported by verifiable evidence, or are they merely rumors and opinions, which gather momentum as they pass from lip to ear? What are the suggested remedies? Will they lead to improvement or merely change?

Before discussing some of the criticisms let us look at the whole problem. Too often the critic looks at only one small segment, such as the lecture method, research, or need for a course in education, forgetting the broad ramifications and implications. There are about eighteen hundred colleges of one kind or another in the United States. These institutions may be somewhat alike or they may be very different, but all of them attempt to educate the youth of the land. Their philosophies, their objectives, and their ways may differ, and they are not too well defined. Equipment in the form of classrooms, laboratories, libraries, teaching staffs, and administrative officers differs widely. Attending these colleges are thousands of students who differ in many ways. Some of them come to college to study and learn; others to attain a certain social status. Still others come with no well-defined purpose. Among those with abilities and with serious purposes, some seek a general education because they think such a background is good for whatever they may do later. Others spend two or three or four years in preprofessional study, usually following curricula outlined somewhat rigidly or specified as entrance requirements by their respective professional schools. I mention these different groups because teaching is more difficult when students of diversified abilities and interests are placed in the same class. Ten years ago, many colleges were approaching the upper limits of their capacities to care for students. Now, with student numbers about doubled, colleges are seriously handicapped for lack of space, proper housing, equipment, and books. Faculties are not only too small—so that classes are too large and teaching loads too great—but the quality has been diluted because there is a scarcity of good, well-trained candidates.

One of the difficulties with all our educational plans is that they cannot be measured with any high degree of accuracy. The end result is the final test and the desired result is not the sum total of accumulated information the student acquires, but men and women of integrity, capable of continued growth, of meeting and solving problems, and of adjusting to changing conditions, successful in their professions and trades, men and women who work for the welfare of their families, their fellowmen, their nation, and the world at large. This end has been reached by devious paths by different men and women, even some with no formal education, and the presumption is that many different kinds of educational programs may still lead students to the same desirable ends. Perhaps the ideals toward which we work, the environment in which we work, and the zeal with which we work are more important than courses, credits, and methods.

Many of us seem to lose our sense of balance, fail to consider facts, and in our discussions of teaching act as though we expected perfection in all teachers—as though college teachers should be required to correct all the ills of students accumulated through 18 years, more or less, of life with parents, secondary school teachers, and other associates of varied shades and hues. Good doctors and good lawyers develop only after years of experience and further study beyond the professional schools. Not all who graduate become good. Only a few become great. The same principle holds for businessmen, bankers, and bakers—and college presidents. Why should we expect more of college teachers? They are human and,

[1] A paper presented at a panel discussion at the AAAS meetings in New York City in December 1949.

like others, make mistakes. Their jobs are no less difficult and may even be harder than other jobs. The undertaker may cover up a doctor's mistakes with six feet of earth. The lawyer may befuddle you with words, but the critics look at teacher's mistakes through magnifying glasses and raise their voices for radical reforms without seeing the problem entire, and without knowing what to do and how to do it.

Scientific knowledge has expanded so rapidly and so widely that no one person can know the whole of any of the few larger fields such as physics, chemistry, or zoology. The result of this expansion has been the subdivision of each of these larger fields into lesser fields. In my own day I have seen the American Society of Zoologists give birth to a genetics society, a human genetics society, an evolution society, an ecological society, and others. The entomologists have been isolated so long they have even forgotten they are zoologists. The result is that scientists, including teachers of science, must concentrate their interests and their energies in limited subdivisions. This movement is taking place at the same time that the sciences, in many respects, are moving closer together. Hence the need for teachers to know interrelated fields is greater than ever before, but the difficulty of meeting this need is also greater than ever before. I offer no solution, but recognition of the problem and the difficulties involved is essential. The difficulties that confront teachers of science also confront students of science.

Good teaching cannot be isolated from all the other activities of the college. It is a resultant of many factors, of which the teacher is only one. If the college administration fails to provide a good library, good equipment, good working conditions, time for good teaching, if scholarship is not respected, if extracurricular activities, social affairs, and athletics are overemphasized, if students assume no responsibilities, good teaching becomes the more difficult.

Most of the criticisms we hear today center around beginning teachers. Here again, there is much confusion and, in the absence of facts, erroneous assumptions and conclusions are frequent. First of all, we do not know how much poor teaching takes place and there is no way of getting the information. For effect, exaggerations are the rule. We are apt to lump all poor teaching together and think of young teachers as responsible, when in fact older teachers may also be to blame. Let us not forget, too, that some of our best teachers are young.

Our critics talk much of educating teachers so they can adjust their teaching to the social needs of our time. But who knows what our social needs are? Even if you do, they may be different tomorrow. You may go along with the administration in thinking, or acting as though you thought, that security from the cradle to the grave is our number one social need. With security you may be willing to sit in your easy chair and let politicians tell you what our social needs are and legislate accordingly. On the other hand, I may prefer opportunity to security, hard work instead of an easy chair, and I may wish to play a part in planning and shaping social trends. And how does one teach zoology or any science to meet these needs? Personally, I do not want students, including prospective teachers, to be trained either in college or graduate school to think in grooves. Instead I prefer to educate students to think for themselves, to be capable of meeting and wrestling with their social problems, capable of adjusting and readjusting. Social conditions today are far different from those of fifty years ago or even ten years ago. What will they be ten years from now? Will they be dictated from Moscow? We seem to forget that students live in our social world and that they are continuously bombarded through the media of newspapers, radio, and public addresses, with comments and discussions of social conditions.

If we study criticisms of college teaching over a period of years they seem to come in waves. Not long ago the emphasis was on methods and techniques. We condemned the lecture system and experimented with the project plan, the contract plan, the honors plan, the preceptorial and tutorial plans, and the plan of individualized instruction. We sectioned on the basis of ability, taught classes both large and small, and examined by various methods and devices. As a result of these studies, many of us have concluded that a good teacher may get good results by any method and that he should choose the method he can use to best advantage. Methods then recede somewhat into the background; they are important from a particular teacher's point of view, but none is of universal application. Because of the increased student numbers and the scarcity of teachers, however, we may be compelled to devise new methods and techniques.

The one outstanding criticism of college teaching concerns teacher education. Before we can discuss teacher education intelligently, we need to know where responsibilities lie, particularly since most critics place the responsibilities upon the graduate schools, apparently forgetting that students have lived twenty or thirty years before entering graduate school, and that these earlier years include education in the home, school, college, and in the world at large. Are not these early years the time and these institutions the places to acquire a broad general education, to develop character, habits of study,

scholarly interests, the ability to read with understanding, and to speak and write with clarity? The graduate school is a school for specialization and although it has an important part to play in the education of teachers it should not be expected to make good all the educational deficiences accumulated in former years.

Before discussing particular ways and means of completing the education of college teachers in graduate schools, it may be well to look at present and past methods. You may think that nearly all teachers hold Ph.D. degrees, but such is far from the truth. In 1928 the North Central Association reported that of 8,743 college teachers, only 33.9 percent held Ph.D. degrees. A similar study made in 1945 of 305 member institutions revealed that in 10 percent of the institutions only 10 percent of all teachers held Ph.D. degrees, while in 70 percent of the institutions only 43 percent of all teachers held such degrees. The median for the entire group was less than 35 percent. Such facts must be kept in mind when we discuss the education of teachers, for it is evident that all poor teaching cannot be traced to Ph.D. programs.

What are the graduate schools now doing and what, if any, changes should be made? In answering these questions I am thinking of graduate education at its best, recognizing, however, that some poor graduate teaching is done and that many students now in graduate schools will never be more than mediocre teachers and researchers.

In the past we talked about more rigid selection of students but did little, except in a few universities. Now, with graduate schools crowded beyond their capacities, selection is more generally practiced. Dean Russell pointed out years ago, however, that selections were on the basis of a student's ability to earn good college grades and not on the basis of his abilities to practice a profession. Although there are good students—how many we do not know—who would be misfits in the teaching profession, most of us believe the correlation between high scholastic ability and good teaching is greater than the correlation between low scholastic ability and good teaching. In some places there lurks the thought that scholars should teach only scholars and, as Linn has expressed it, teachers of the lower 80 percent of college students who are not potential scholars should be taught by teachers who are not scholars but merely intelligent and humane.

From whatever angle we look at it, the admissions problem is complicated. Possibly, in time, tests may be devised that will enable us to separate more accurately the sheep from the goats, but until then we shall select as wisely as we can, knowing that misfits cannot be excluded and hoping that college administrators will use greater care and better judgment in selecting their teachers; hoping also that graduate school teachers will more accurately tell the truth in their letters of recommendation.

Even as now selected, graduate students are a heterogeneous lot. A high percentage of them become teachers in high schools, colleges, and universities, and work toward fulfilling requirements for either the M.A. or Ph.D. degree. A smaller number wish to qualify for research positions only. Others come for an additional year or more, for various reasons, and are not candidates for degrees, but prefer to pick and choose at will.

The M.A. degree, as administered in nearly all universities at present, cannot be thought of as preparation for college teaching, even though many so trained are employed as college teachers. The degree may be nothing more than an additional year of college work, or college work plus courses in education. If we dismiss the M.A. degree from consideration the main question is whether the requirements for the Ph.D. degree prepare students for college teaching. It is this degree that has been and still is the focus of attack. Many unkind things have been said about it and about teachers educated by this route.

Just what would the critics have the graduate schools do? If we go back fifteen or twenty years, we find that the Association of American Colleges asked for a course on the American college and another on methods and practice teaching, while the North Central Association asked that graduate schools acquaint prospective teachers with the literature on student personnel, college curricula, college instruction, and college organization and administration. Judd recommended that we train all prospective college teachers "in the methods and results of inquiry in the subjects which they are to teach, in the methods of critical evaluation of the results of teaching." He also wanted us to understand the American educational system. In addition to the recommendations of the North Central Association, Haggerty added that all teachers should be trained in the techniques of educational research. Suzzallo specified a minimum of three courses, one on the American school system, a second on the psychology of learning, and a third on practice teaching. Suzzallo also recommended that we send prospective teachers to schools of education, leaving scholars in the graduate schools. In response to the request of the Association of American Colleges, the Association of American Universities sanctioned a course on the problems of the college and another on methods and teaching under supervision, both to be given by subject-matter departments, and both to be optional.

College teachers themselves, through the American Association of University Professors, recommended:

(a) That the academic departments consider what they might do to give their graduate students necessary training and supervision in the teaching of their respective subjects.

(b) That they sanction an optional seminar on problems of American education with special reference to the college, to be given by the school of education or by this school in cooperation with the academic departments.

From the report of the President's Commission on Higher Education I quote:

1. The most conspicuous weakness of the current graduate programs is the failure to provide potential faculty members with the basic skills and the art necessary to impart knowledge to others.

2. The failure of individuals to learn how to teach is largely the failure of the present graduate school system. Inflexible requirements for the degree, the formality and dispersion of the established curriculum, the absence of programs designed to develop skill in presenting subject matter and the lack of appropriate guidance have been largely responsible for the fact that advanced degrees frequently do not indicate an ability to teach.

3. This Commission holds that the academic offerings of the graduate schools should be suited to the needs of students who are preparing for careers in higher education.

4. He [the student] should be given the opportunity to become especially proficient in some area of human knowledge, but not to the extent of overspecialization. The degree of specialization should vary somewhat with the teaching field, but in general it should follow the professional rather than the academic pattern. [Note the word *professional!*]

5. Drastic changes of policy may be necessary in many graduate schools if they are to plan teacher preparation studies which will be professionally realistic.

6. The successful completion of the teacher preparation program should be indicated by some suitable designation. [Here is an entering wedge to teacher certification.]

7. This Commission recommends that the graduate schools take advantage of the opportunity and the obligation to make a distinguished contribution through providing internship training for those who plan to enter these different fields.

8. The faculty member who is to grow professionally and preserve his vitality of outlook must be equipped to grow independently. [We differ here only as to methods of equipping teachers so they may grow independently.]

9. This Commission proposes the extension of formalized programs aimed at teaching the methods of investigation. (Note the expression *formalized programs.* Several years ago I read a book of more than 600 pages on how to do research in education. The one thing I learned from that profound discussion was that if I wanted to do research I must first select a problem.]

For the past fifteen years the chairman of the President's Commission has been expounding reforms similar to those expressed in the Commission's report. Recently a conference on the preparation of college teachers was held in Chicago. It was sponsored by the American Council on Education and the U. S. Office of Education. I quote only from the remarks made by Commissioner McGrath:

1. Graduate faculties are attempting to perform two dissimilar functions without apparently recognizing their difference. [I didn't know we were so dumb.]

2. The primary responsibility of the graduate school is to produce creative minds. It should educate scholars and research workers, not college teachers. The training of teachers should be the responsibility of a professional division of the university. [In other words, the school of education.]

What do teachers of science think about the education of college teachers? I speak for myself only. I do think it important, however, that other science teachers speak before it is too late. Who knows more about how teachers should be educated than teachers themselves, even though Capen has called us laymen with respect to educational questions? If my information is correct, there is not more than one person on the President's Commission who is now active in the teaching profession. Some have been teachers but when a teacher becomes an administrator he seems to undergo a complete metamorphosis.

Can teachers of science defend the Ph.D. program as the best way to educate college teachers of science? The answer to these questions will depend somewhat upon what we think good teaching is. Committee U of the American Association of University Professors has defined good teaching as that which stimulates the student to learn as a result of his own efforts. A similar concept of teaching was expressed by Meiklejohn when he said that teaching is not the giving of information, but the stimulating and directing of the mind by other minds that are going in the same direction. President Lowell has said that good teaching should be self-education under guidance. With these concepts I agree and what follows will be colored by them.

Requirements for the Ph.D. degree, as judged by catalogue descriptions, are much alike the country over and consist of four major items.

1. Broader and deeper knowledge of a field of specialization.

2. More limited knowledge of fields or a field related to the major field of specialization.

3. The thesis.

4. The final comprehensive examination.

All these requirements are variables, depending upon the teachers and administrators who supervise and enforce them and upon the students who are also

variables. The program is not rigid and inflexible, as some would have you believe, but is built around the needs of the student by a committee working with the student. Within the broad general framework of the requirements as stated, the commitee has much latitude and may even cut across departmental lines. A broad knowledge of the field of specialization may be stressed more by some than by others. The same statement may be applied to related fields. Perhaps the thesis is the most variable of all. You must be familiar with the diatribes written on the subject. In some instances, so it is said, it may begin with the trivial and end with the obvious, while in others an essay may be substituted. At best it may be an exciting journey of exploration into the unknown. The final comprehensive examination may be superficial or exacting.

In defending these requirements I do so on the assumption that they are enforced with fairness, justice, and flexibility, but at the same time with high scholastic standards, keeping in mind the development of the individual student to the point where he has the foundation for continued growth and where he can do either teaching or research or both with some degree of efficiency. No one, to the best of my knowledge, has proclaimed that students who complete requirements for the Ph.D. degree are more than beginners at either teaching or research.

I also assume that college graduates applying for entrance will be carefully screened with respect to scholastic abilities and previous education, and insofar as possible with respect to their interests and abilities in teaching. No one can take any and all comers and make good teachers of them.

Perhaps most or all of us would agree that a broad knowledge of the field of specialization and related fields is desirable, even though we would not say it is necessary. One difficulty, however, lies in the fact that knowledge has expanded to the point where only a few people are able to carry out the full intent of these requirements.

In discussing the thesis requirement, I assume that the student, after consultation with teachers, selects a problem, an unknown, which he wishes to study and explore. The problem should not be a small, circumscribed one which, when the investigation is completed, leaves nothing more to do. Preferably, the problem should be an approach to, or a segment of, a larger field of investigation. When this type of thesis is completed the unknowns have increased because the student's range of vision has been enlarged and he is led on and on so that he becomes an investigator for the rest of his life.

I assume also that the student does the work with a minimum of guidance by the teacher. There may be some floundering, some loss in following blind alleys, some backtracking, but the student must learn to work and to think independently, and he does not acquire these qualities if he is continuously under the direction and supervision of a teacher who tells him what to look for around the corner and the next corner.

The thesis is required for the purpose of teaching students to do research, but it also has another important function. I challenge you to find a better way of testing and developing the student's interests, powers of observation, his initiative, imagination, drive, judgment, and abilities to interpret data and solve problems.

No one, to my knowledge, has criticized the final comprehensive examination, and so it seems to need no defense.

What about courses in education? Should they be required, and if so should they replace some of the present Ph.D. requirements, or should they be added to them? I have already stated the insistent demands of the critics. To me, this is one of the most important questions facing colleges, graduate schools, and teachers. Our ideas of what good teaching is, as well as our philosophy of education, are at stake.

The trend in many colleges has been toward professionalized and vocational courses and curricula, in which students are taught specific things in specific ways in order to prepare for specific jobs. Perhaps teachers of these students should also be taught in specific ways. But I am not discussing the education of this kind of teacher. Instead, I am thinking of teachers in colleges that still offer opportunities for students to learn to live as well as earn a living, where scholarship is respected, where it is held that the acquisition of knowledge is an end in itself worth attaining, where students may acquire a general education. Such teachers must be able to think for themselves, to see, to meet, and to solve problems as they arise. They must not be cast in bronze over a hypothetical model of clay.

I have no objections to college students' taking a course in the philosophy or history of education, or a course in psychology; but how much use a college teacher makes of such courses in the classroom no one knows, and there can be no reason for introducing them into the graduate program unless they are of direct practical value. I see no need either in college or graduate school for a course on the American college or the American school system. Neither do I see a need in the graduate school for a course on the techniques of educational research. They are not so intricate that they cannot be mastered whenever a need for their use arises. Here is another example of minds running in the well-worn

groove—the assumption that everything we learn must be taught in courses.

While I would refuse requests for courses in education, I suggest that graduate schools consider the need for practice teaching and a seminar on college problems. To the educationists I suggest that they write some good books and include material they think college teachers should know and use but omit nonessential details. We think we are capable of reading and understanding, and we also think we are capable of judging values.

What I have said will not satisfy the critics. Their requests, however, are not supported by convincing evidence that better teaching would result if their advice were followed, or even that they themselves are better teachers.

After forty years of experience, I presume I should be wise enough to tell how science should be taught in college and how a science teacher should be educated, but the longer I live the less sure I am of the answers to such questions and the surer I am that no one else has final answers. This does not imply, however, that one answer is as good as another.

If I were to venture to make a few suggestions, not because they are new but by way of emphasis, they would run something like this. To young people thinking of entering the profession, I would say: Be sure you want to make teaching your life work and that you have the personal qualifications for success. If you are looking for an easy job, or can't be satisfied with a modest income, look elsewhere. If you decide to teach, educate yourself as best you can but there is no one pattern that must be followed. I suggest you emphasize both breadth and depth. Don't neglect the humanities, social sciences, and fine arts, for they too will add breadth worthy of acquisition, and add to your enjoyment of life. See and learn as much of the world and of peoples as possible. Learn to do research, for research activity will do much to keep you a live, virile teacher. Continue to be a student of the subject you teach and of teaching problems. You will never reach perfection, for it is neither in your genes nor in the environment. Know how good teachers teach, listen to suggestions and criticisms, then make your own decisions in the light of what you are attempting to do. Be yourself. Don't let your enthusiasm for your subject cause you to attempt to develop all students into specialists. Most students have other interests, and want science merely to add to their breadth of education or to satisfy their curiosity. Such students are worthy of your best efforts as a teacher. Never lose sight of the fact that a good teacher guides, and that a student learns by his own efforts. Encourage the reading of good books. Teach some things by example. By all means, remember your students will be citizens of the United States of America and that they will play significant parts in the development of our country. Differentiate sharply between propaganda, indoctrination, and education.

The Role of the Time Factor in Protein Synthesis[1]

Ernest Geiger

School of Medicine, University of Southern California, Los Angeles, and
The Van Camp Seafood Company, Terminal Island, California

IT IS A FUNDAMENTAL CONCEPT that proteins are composed of amino acids and that the number and spatial arrangement of these building stones characterize the individual protein. This leads logically to the hypothesis that protein synthesis can proceed only if all the building stones involved are available.

This truism more or less exhausts our knowledge of the mechanism of protein synthesis. Cannon (*4*) recently emphasized the fact that in spite of our growing knowledge of the catabolic phase of protein metabolism, there are wide gaps in our understanding of its anabolic phase, and Northrop (*20*) called attention to our lack of knowledge concerning not only the energetics of protein synthesis but also the nature of the basic building stones of proteins: viz., whether proteins are synthesized directly from amino acids or from larger intermediary building stones, so-called plasteins.

The plastein theory of protein synthesis in its original naive form (Sawjalow, 1899), or in its recent revision, is based on the reversibility of protein hydrolysis *in vitro* and therefore can hardly account for the specificity of the synthesized proteins.

Even the epochal experiments of Schoenheimer and his colleagues shed little light on the problems of protein anabolism. The ease with which labeled amino acids have been incorporated into protein, however, forecasts a drastic revision of our current ideas on the rigid structure of living protein.

[1] Based on a lecture given at the Gordon Research Conferences, AAAS, August 14, 1949.

The problem of protein synthesis was approached by the present author several years ago by feeding "incomplete" amino acid mixtures. W. C. Rose had shown earlier that protein synthesis occurs only if all the "essential" amino acids are present in the diet. This stimulated the investigation here of the metabolic fate of incomplete amino acid mixtures which, because of the lack of one or more essential amino acids, cannot be utilized for protein synthesis.

Three possibilities were considered: (1) that the amino acids can be stored in the body as such, representing thereby a stock pile from which protein synthesis can proceed as soon as the lacking building stones are supplied; (2) that they are stored in the form of osmotically less active peptides; and (3) that they are irreversibly further metabolized, and are therefore lost for protein synthesis.

It was established first, by amino acid analysis of the tissues, that those amino acids which are not immediately utilized for protein synthesis are not stored as such in the body (*8*). Consequently an attempt was made to determine whether synthetic processes, such as plastein formation, could produce from the incomplete amino acid mixtures peptides of smaller or larger sizes which in turn could be synthesized into proteins as soon as the missing amino acids were added to the diet. However, it was found that feeding the missing amino acid several hours after consumption of an incomplete amino acid mixture did not promote protein synthesis as measured by the effect on growth (*8*). These experiments show that the incomplete amino acid mixtures are not utilized for the formation of intermediary building stones from which further synthesis could proceed at a later time, but are metabolized, probably irreversibly. Thus, there was found no support for the theory that protein synthesis is a piece-by-piece affair, but rather the experimental results favor a mechanism like the template method of formation in the sense of Langmuir-Schaefer or Pauling.

The fact already postulated by Rose, Mitchell, and Elman, that protein synthesis occurs only when all the essential amino acids are simultaneously available, has been thus experimentally established.

Cannon arrived at similar conclusions independently, using the repletion of protein-depleted adult rats as an indicator of protein synthesis. A further welcome confirmation was recently reported by Henderson and Harris (*14*), who found that "a delay of 3 hours or longer in the feeding of lysine as a supplement to a lysine low diet interfered with metabolism."

All of these findings are relevant to the *essential* amino acids. However, the nature of protein synthesis makes it mandatory to assume that the nonessential as well as the so-called essential amino acids must be available simultaneously and in ample quantities to permit protein synthesis. Although the animal does not require the nonessential amino acids in its diet, it is clear that they must be produced in the intermediary metabolism and provided as free amino acids in sufficient quantities to secure the optimal utilization of the essential amino acids (*2*). It is evident that the "law of minimum" is valid also for the nonessential amino acids, so that protein synthesis is limited not only by the supply of the dietary essential amino acids, but also by the speed with which the so-called nonessential amino acids are made available.

The experiments of Cox and Mueller (*6*) and of Rose (*22*) have actually shown that feeding all of the amino acids simultaneously is more effective than feeding of the essentials alone, and these tests therefore provide experimental proof for the rule just stated.

Speedy availability of the nonessential amino acids depends on the proper functioning of the conversion mechanisms and it seems probable that some of the pathological disturbances of protein formation—for example, in liver disease—may be the consequence of a disturbance in the formation of these nonessentials. It is evident that the formation of nonessentials depends also upon the supply of easily available precursors for these amino acids, such as sugar or fat. A somewhat older and as yet unexplained finding may be interpreted in this way. Larsen and Chaikoff (*16*), working with adult dogs, and Cuthbertson *et al.* (*7*), studying adult humans and rats, showed that the N-sparing effect of a single carbohydrate feeding was related to the time elapsed between the consumption of the daily meal and the ingestion of the extra carbohydrate. We found later (*9*) that the growth of infantile rats is likewise affected by the temporal separation of feeding of protein from the feeding of the remainder of the diet. It seems logical to assume that carbohydrates, which provide the necessary precursors for the formation of the nonessential amino acids, can be utilized for protein formation optimally only if fed simultaneously with the essential amino acids. To test this point, experiments are in progress in which we investigate whether a single dose of labeled sugar given simultaneously with the essential amino acids is deposited in the body proteins to a larger degree than when sugar is given four or five hours after the protein meal.

Considering the role of the time factor in protein synthesis, we have to conclude that optimal utilization requires the simultaneous availability of adequate amounts of all of the essential and nonessential amino acids participating in the make-up of the given protein.

Before drawing general conclusions from the results obtained so far, we should discuss the question of whether there are some basic differences between the role of the time factor in the use of amino acids for growth and its role in their use for maintenance metabolism. The existence of such foundamental differences has been assumed by several authors, but others—for instance, Wissler and his collaborators (*27*)—suggest that the requirement in respect to amino acids for maintenance does not differ essentially from the requirement for growth. Experiments with delayed supplementation were therefore undertaken to decide between the two possibilities. Cannon, in his investigations on repletion of protein-depleted adult rats, demonstrated in short term experiments that repletion occurs only if all the essential amino acids are supplied simultaneously. We recently repeated Cannon's experiments with a somewhat different technique, and found that, in long term experiments as well, repletion in adult rats occurs only when tryptophan is fed simultaneously with the other essential amino acids. Cannon's results, as well as our own experiments with repletion, shed little light on maintenance itself. The repletion process, i.e., the repair of lost tissue, is essentially equivalent to protein formation in growth. Repletion in adult rats, therefore, like growth promotion in infantile rats, requires the simultaneous presence of the essential amino acids.

It may be assumed a priori, from the work of Schoenheimer and his group, that although formation of new protein in growth and repletion is an all-or-none matter, the existing, aging protein molecules may be mended by a piece-by-piece replacement of the individual amino acids. This would imply that the so-called "give and take" between dietary and tissue amino acids is not restricted to the simultaneous presence of all the building stones. To test this concept, adult normal rats were fed for 12 hours on a tryptophan-free diet and the missing amino acid was supplied 12 hours later. It was found that the adult rats receiving tryptophan as a delayed supplement lost weight as fast as or faster than the control rats receiving none of the amino acids in their diets. This observation shows that maintenance metabolism in adult rats requires the simultaneous presence of all the essential amino acids. Therefore, the concept of "dynamic equilibrium" has to be interpreted as a replacement of whole protein molecules destroyed in continuous metabolism. This process evidently requires also the simultaneous presence of all the amino acids.

The experiments of Sanadi and Greenberg (*24*) with labeled amino acids support this point of view. These authors found that animals reared on a diet deficient in one essential amino acid showed a reduced incorporation of C^{14} from labeled tryptophan or glycine into their tissue proteins. It would be interesting to study tracer incorporation by applying the technique of delayed supplementation. Such experiments may show to what extent the exchange of the individual amino acids between tissue and dietary proteins is influenced by the presence or absence of certain essential amino acids. This problem requires further investigation because it has been shown recently (*3*) that the uptake of labeled lysine by guinea pig liver homogenates may occur *in vitro* in the absence of other amino acids. However, it is possible that the products of continuing protein hydrolysis *in vitro* are not removed and can, therefore, be reutilized for protein synthesis. The conditions *in vivo* are very different and this may explain why in adult rats, for all practical purposes, the time factor in the provision of amino acids is as important for maintenance metabolism as for promotion of growth.

The rule that all the amino acids have to be present simultaneously for protein synthesis does not imply that amino acids fed singly cannot be utilized by the organism at all. Besides participating in protein synthesis, amino acids are utilized by the organism for formation of vital factors such as vitamins, hormones, and coenzymes. Whether the utilization of the individual amino acids for these purposes may proceed also in the absence of the other amino acids has been the subject of investigation. In such experiments with tryptophan it was found that the method of delayed supplementation aids in distinguishing between the "protein function" of the amino acids and their "extraprotein functions," such as the formation of vitamins, coenzymes, hormones, biogen amines, or still other unknown compounds.

First the development of cataract in tryptophan-deficient rats was studied (*26*), and it was found that tryptophan had to be supplied along with the remainder of the protein moiety, rather than at a later time, in order to prevent the lesion. In the case of delayed supplementation, cataract formation occurred even though the animals consumed relatively large amounts of tryptophan. This clearly established the fact that cataract formation is a consequence of a disturbance in protein synthesis, and eliminated the possibility that tryptophan prevents the cataract formation by some specific action.

The same technique was applied to determine whether niacin synthesis from tryptophan occurs independently from protein synthesis.

In experiments on rats (*12*) in which a niacin deficiency had been produced by a diet imbalanced in amino acid—containing, for example, 9 percent casein

and 6 percent gelatin—the tryptophan supplement proved to be equally effective in promoting growth whether fed simultaneously with or several hours after the imbalanced diet. Here we find that the corrective effect, contrary to that in growth promotion and cataract prevention, is manifested even when the amino acid is fed as a delayed supplement. Therefore, the transformation of tryptophan to niacin may be considered to be independent of protein synthesis.

It should be pointed out that the animals in the present experiments grew and excreted increased amounts of niacin even though tryptophan was given as a delayed supplement. This appears to contradict the experiments reported earlier in which animals on a diet *completely* deficient in tryptophan did not grow when the amino acid was given as a delayed supplement. In the present experiments, however, the deficient diet *per se* contains enough tryptophan in the form of casein to promote growth, and only the harmful effects of imbalancing the amino acid ratio by feeding gelatin had to be corrected by supplementation with tryptophan.

We must conclude from these experiments that tryptophan can be utilized along at least two pathways: first for protein synthesis and then secondly, probably independently, for niacin synthesis. In order to test the possibility of diverting the tryptophan utilization predominantly in one of these directions, niacin formation was investigated in animals where protein synthesis was depressed by the omission of cod liver oil from the diet. Such experiments have shown, however, that lack of cod liver oil interferes not only with growth but also with urinary nicotinic acid excretion; after the addition of cod liver oil, growth and nicotinic acid excretion increased nearly equally, independent of whether the tryptophan was mixed with the diet or fed as a delayed supplement. This shows that when growth ceases on a diet free of cod liver oil, the formation of nicotinic acid from tryptophan is not increased, but is in fact decreased. So it was not possible to demonstrate in this way any preference or competition in utilization of tryptophan either for protein or for niacin formation.

We should like to call attention to the fact that the curative effect of tryptophan in niacin deficiency can be prevented by the absence of cod liver oil as well as by the lack of the B vitamins, as reported before. This finding reemphasizes the complex interdependence of the different processes of intermediary metabolism.

Further experiments are in progress in which the deficiency symptoms and pathological changes in rats kept on a diet entirely free of methionine are compared with the symptoms developed by rats that receive methionine as a delayed supplement to the remainder of the diet. The results may indicate which of the symptoms are connected with altered protein synthesis and which are related to extraprotein functions of this amino acid. These experiments may also test the assumption of Salmon (*23*) that "one would expect more of the methionine methyl to be available for choline synthesis when methionine is fed as the sole supplement than when fed along with the other essential amino acids in the protein molecule."[2]

In this connection, attention should be called to the experiments of Paloheimo (*21*) who, incidentally, seems to be the first to have investigated the effects of delayed amino acid supplementation. Based on the findings of Osborne and Mendel that added cystine has a casein-sparing effect, he fed rats a diet low in casein at 48-hour intervals, and between meals supplied small amounts of cystine. He found a definite increase in the N-retention and assumed therefore that either the amino acids of casein or the cystine itself may be stored in the organism for a period of 12 hours or longer. However, more recent experiments fail to support any such amino acid storage. Paloheimo suggested, as a further possibility, that the cystine might also form some lower molecular compounds of biological importance, such as glutathione, which improve the animals' general condition. The author fails to explain why, in spite of improved nitrogen retention, the rats did not grow.

All of the experiments discussed thus far were performed with amino acid mixtures and therefore their results are primarily of theoretical interest: their practical value is restricted to those instances where mixtures of amino acids are fed or injected. To extend this type of study to more practical situations, the significance of the time factor in the feeding of supplementary proteins had to be investigated. The factors of slow digestion of the protein and slow absorption of the amino acids might equalize the effects of delayed supplementation. It was found (*10*) that feeding proteins with individually low biological value yielded mutual supplementation only when they were given simultaneously. If the same pairs of proteins were fed temporally separated they failed to supplement each other. That is, delayed provision of missing amino acids is ineffective not only when the amino acids are fed in the free state, but also when they are supplied in the form of proteins. These experiments confirm the results of Henry and Kon (*15*), who found that such complex foods as

[2] To facilitate the study of such problems, a mechanical device for controlling the time of feeding of rats has been constructed. The apparatus was built by the Precision Instrument Shop of the University of Southern California Medical School, with funds generously provided by the National Vitamin Foundation.

milk, potato, bread, and cheese exhibit supplementary relationships only if fed together and not if fed separately on alternate days.

The practical consequence of all these findings may be very briefly summarized. First, in the feeding of proteins of low biological value, as in relief feeding or in emergency diets, the proteins should be fed together to secure the maximum benefit of any possible supplementary action. For example, according to Adolph (*1*), the Chinese consume different cereals mixed in definite proportions. In this fashion they have developed empirically a protein mixture of high biological value. An empirical wisdom similarly developed may be responsible for the timing, sequence, amount, and composition of the meals consumed throughout the world. It is an intriguing task for further research to verify or disprove the value of such practices developed throughout the ages. A very important step has been made recently in this direction by Leverton and Gram (*17*).

Second, in compounding amino acid mixtures for therapeutic uses, it is not sufficient to simulate the composition of good quality proteins; instead, the relative amount of the individual amino acids should be chosen in such a way that, in spite of differences in absorption, excretion, and destruction, optimal utilization for protein synthesis should be secured (*13*). This requires much further work on the fate of the individual amino acids and amino acid mixtures. In this connection, an important problem of general interest is the question of the significance of the time differences in the gastrointestinal enzymatic liberation of the amino acids as a factor in the effective utilization of certain dietary proteins. Melnick and his collaborators (*19*) were the first to suggest such a mechanism as an explanation for the poor utilization of raw soybean protein; they showed that methionine is released more rapidly from the heated than from the raw meal. They suggest that the methionine is released from the raw meal so late in the intestinal transit that this amino acid, as well as the other incompletely supplemented amino acids, is not optimally utilized for protein synthesis. In the light of recent studies (*18*) it seems possible that some of Melnick's results may require a somewhat revised interpretation. The heuristic value of Melnick's conclusions, however, cannot be overemphasized, and in all further investigations on the digestibility of proteins it will be compulsory to consider also the time relations of enzymatic liberation and intestinal absorption of the constituent amino acids. We do not believe that conclusions based solely on digestion *in vitro* are of much value because the released amino acids are absorbed at different speeds from the intestinal tract.

Results of experiments with zein (*11*), which we tried to explain according to Melnick's theory, called our attention to still another factor which may influence the adequacy of a protein, viz., peptides formed by incomplete enzymatic digestion may in certain instances interfere with growth.

Attempts to determine the maximum time interval at which a missing amino acid may still be effectively supplied yield results which have to be further investigated. It was found that effective supplementation of the missing amino acid is possible only if the time interval is less than four or five hours, in spite of the fact that there are still considerable quantities of the deficient protein present in the intestinal tract of the animal at this time. This phenomenon may be explained either by the assumption that the original, imbalanced protein produces a continuous damage (Allison, Elvehjem), thus blocking the effective utilization of normal proteins when absorbed at a later time; or, alternatively, we may assume with Christensen (*5*) that the exessive concentration of certain amino acids may block, by a mechanism of competitive inhibition, the utilization of the missing building stones fed later. This problem is now being studied.

Another fundamental problem which arises from the studies of the time factor in amino acid supplementation is the ultimate fate of those amino acids that could not be utilized for protein synthesis. We have already pointed out that they are not stored in the body as amino acids or as peptides. Experiments of Schweigert and of Sauberlich and Baumann (*25*) showed that feeding incomplete proteins increases the urinary amino acid excretion, and that "there is a rough inverse correlation between the growth stimulating power and the percentages of ingested amino acids excreted in the urine." Since only 15 percent to 25 percent of the ingested amino acids of a deficient mixture can be recovered from the urine, it is still necessary to account for the remainder. A possible transformation and deposition in the form of fat or carbohydrate has to be ruled out because it would obviously also increase the body weight. The metabolized end products must be excreted in the form of organic compounds in addition to urea, or destroyed by catabolic processes. The possibility of an altered respiratory metabolism as a consequence of feeding incomplete proteins has not yet been investigated, but we suggest that the elimination of these unutilized amino acids may account, at least in part, for the so-called "specific dynamic action." An experimental investigation of this relationship may clear up many controversies in this field.

The investigations discussed in this review indicate that the method of delayed supplementation of amino acids can be successfully employed for the study of

the mechanism of protein synthesis as well as for the study of the specific "nonprotein" functions of the individual amino acids, and for the identification and separation of the two functions. Experiments performed with this technique show that incomplete amino acid mixtures are not stored in the organism or used for the formation of intermediary building stones (plasteins), from which protein synthesis could proceed at a later time.

The results of several authors suggest that the law of minimum is valid not only for the essential, but also for the nonessential amino acids, so that protein formation is dependent not only upon the simultaneous presence of the essential amino acids, but also upon the speed with which the nonessential amino acids are made available. The study of the mechanisms by which formation of the nonessential amino acids is controlled seems therefore to be an important, though neglected, field for investigation.

These experiments with delayed supplementation fail to support the theories which assume that protein metabolism may be basically different in processes of growth and of maintenance.

As we see it, the whole problem of the time factor in supplementation seems to center around the puzzling question of how the organism determines whether a given amino acid mixture is to be retained for protein synthesis, or instead, because of an amino acid inadequacy, to be disposed of. Does this selection occur in the liver, or is the amino acid fixation and retention determined by some protein-forming templates? We hope that this problem may be approached experimentally in the near future, but in the meantime the "wisdom of the body" must be given credit for this selective retention.

References

1. ADOLPH, W. H. *Science*, 1944, **100**, 1.
2. ALMQUIST, H. J. *J. Nutrition*, 1947, **34**, 543.
3. BORSOOK, H. *et al. J. biol. Chem.*, 1949, **179**, 705.
4. CANNON, P. R. *et al. Fed. Proc.*, 1947, **6**, 390; 1948, **7**, 391.
5. CHRISTENSEN, H. N. *Fed. Proc.*, 1949, **8**, 191.
6. COX, W. M., JR. and MUELLER, A. J. *Fed. Proc.*, 1944, **3**, 56.
7. CUTHBERTSON, D. P., MCCUTCHEON, A., and MUNRO, H. N. *Biochem. J.*, 1940, **34**, 1002.
8. GEIGER, E. *J. Nutrition*, 1947, **34**, 97; Dissertation. University of Southern California, 1946.
9. ———. *Science*, 1948, **108**, 42.
10. ———. *J. Nutrition*, 1948, **36**, 813.
11. GEIGER, E. and HAGERTY, E. B. 115th meeting, Amer. chem. Soc., San Francisco, 1949.
12. GEIGER, E., HAGERTY, E. B., and GATCHELL, H. D. *Arch. Biochem.*, 1949, **23**, 315.
13. HARPER, H. A. *Proc. Soc. exp. Biol. Med.*, 1949, **72**, 184.
14. HENDERSON, R. and HARRIS, R. S. *Fed. Proc.*, 1949, **8**, 385.
15. HENRY, K. M. and KON, S. K. *J. dairy Res.*, 1946, **14**, 330.
16. LARSEN, P. S. and CHAIKOFF, I. L. *J. Nutrition*, 1937, **13**, 287.
17. LEVERTON, R. M. and GRAM, M. R. *J. Nutrition*, 1949, **39**, 57.
18. LIENER, I. E. and FEVOLD, H. L. *Arch. Biochem.*, 1949, **21**, 395.
19. MELNICK, D., OSER, B. L., and WEISS, S. *Science*, 1946, **103**, 327.
20. NORTHROP, J. H. *The chemistry and physiology of growth*. Princeton: Princeton Univ. Press, 1949.
21. PALOHEIMO, L. *Biochem. Z.*, 1937, **295**, 48.
22. ROSE, W. C., OESTERLING, M. J., and WOMACK, M. *J. biol. Chem.*, 1948, **176**, 753.
23. SALMON, W. D. *J. Nutrition*, 1947, **33**, 155.
24. SANADI, D. R. and GREENBERG, D. M. *Proc. Soc. exp. Biol. Med.*, 1948, **69**, 162.
25. SAUBERLICH, H. E. and BAUMANN, C. A. *Fed. Proc.*, 1948, **7**, 183.
26. SCHAEFFER, A. J. and GEIGER, E. *Proc. Soc. exp. Biol. Med.*, 1947, **66**, 309.
27. WISSLER, R. W. *et al. J. Nutrition*, 1948, **36**, 245.

Technical Papers

The Detoxification of DDT by Resistant Houseflies and Inhibition of This Process by Piperonyl Cyclonene

A. S. Perry and W. M. Hoskins

Laboratory of Insect Physiology and Toxicology, Division of Entomology and Parasitology, University of California, Berkeley

It has been found by numerous experimenters that the common housefly (*Musca domestica*) becomes less susceptible to the toxic action of DDT after one or more seasons' exposure. The marked increase in effectiveness of pyrethrin solutions when various so-called synergists are added has led to the hope that synergists might be found for DDT, but no marked effect has been reported to date.

TABLE 1

EFFECT ON MORTALITY OF FLIES OF ADDING VARYING AMOUNTS OF PIPERONYL CYCLONENE TO DDT

	DDT µg/fly	Piperonyl cyclonene µg/fly	% Mortality
A. Berkeley laboratory strain	0.05	0.0	43.3
	"	0.1	45.6
	"	1.0	42.9
	"	5.0	24.4
	"	10.0	18.2
	0.0	10.0	0.0
B. Laton strain	0.5	0.0	50.6
	"	0.1	58.5
	"	1.0	72.5
	"	5.0	93.4
	"	10.0	100.00
	0.0	10.0	0.0
C. Bellflower strain ...	5.0	0.0	42.1
	"	1.0	51.2
	"	5.0	70.4
	"	10.0	76.6
	"	25.0	87.9
	"	50.0	76.8
	0.0	50.0	0.0

A study of several synergists for pyrethrin showed that piperonyl cyclohexenone (piperonyl cyclonene) markedly increases the toxicity of DDT for the DDT-resistant strains of houseflies, but has little or no effect with the ordinary susceptible strain when acetone solutions are applied topically. Typical results with groups of 50 females flies are shown in Table 1. The three strains are: a nonresistant one taken in Berkeley and called "Berkeley laboratory strain," a moderately resistant one, "Laton strain," and a highly resistant one, "Bellflower strain." Preliminary results with DDD and with methoxychlor show similar effects.

The above mortalities were obtained by applying the chemicals together in acetone solution and hence might be interpreted as resulting from more rapid or complete penetration of the integument by DDT when the synergist was present. This is not the case, for separate application to different parts of the body resulted in the same increase in mortality. In fact, larger amounts used jointly appear to retard penetration and decrease mortality of the Berkeley strain (cf. Table 1). Hence an explanation was sought in changes undergone by DDT after absorption.

TABLE 2

AMOUNTS OF INTERNAL DDT AND DDE RECOVERED FROM DDT-SUSCEPTIBLE AND RESISTANT STRAINS

	DDT applied µg/fly	Internal DDT recovered µg/fly	Internal DDT recovered Percent of amount applied	Internal DDE recovered µg/fly	Internal DDE recovered Percent of amount applied
Berkeley laboratory strain					
(a) dead	0.05	0.026	52.0	0.024	48.0
(b) living	0.05	0.015	30.0	0.033	66.0
Laton strain					
(a) dead	0.5	0.093	18.6	0.088	17.6
(b) living	0.5	0.0	0.0	0.250	50.0
Bellflower strain					
(a) dead	5.0	0.490	9.8	0.874	17.5
(b) living	5.0	0.376	7.5	1.654	33.1

Twenty-four hours after application the flies were thoroughly rinsed in chloroform to remove adhering DDT and then were ground and again extracted with chloroform. DDT was determined colorimetrically by the Schechter-Haller method. In some instances a reddish color was produced in addition to the customary blue color. This is an indication of some degradation product, e.g., the acetic acid derivative (DDA), the ethylene derivative (DDE) or perhaps dichlorobenzophenone. The substance giving this color appears not to be removed by dilute alkali and hence the simplest assumption is that it is the ethylene derivative DDE. Some typical results are given in Table 2.

It is obvious that increased ability to convert absorbed DDT into DDE is characteristic of the resistant strain. In a given experiment, the survivors on the average always had converted more DDT than those that died and hence ability to make this conversion is a major factor in variation in resistance within individuals of a given strain.[1]

Similar analyses on flies that had been treated with the DDT-piperonyl cyclonene combination showed that the conversion to DDE is largely prevented. Hence the synergism is, at least in part, an interference with the

[1] Dr. C. W. Kearns of the University of Illinois has stated in correspondence that similar results obtained in his laboratory are now in press.

TABLE 3

EFFECT OF PIPERONYL CYCLONENE ON CONVERSION OF DDT TO DDE

	DDT applied µg/fly	Piperonyl cyclonene µg/fly	Internal DDT recovered µg/fly	Internal DDT recovered Percent of amount applied	Internal DDE recovered µg/fly	Internal DDE recovered Percent of amount applied
Laton strain						
(a) dead	0.5	10.0	0.115	23.0	0.030	6.0
(b) living ...	0.5	0.0	0.0	0.0	0.250	50.0
Bellflower strain						
(a) dead	5.0	25.0	0.793	15.8	0.173	3.4
(b) living ...	5.0	0.0	0.376	7.5	1.654	33.1

detoxification process. Typical data for the Laton and Bellflower strains are shown in Table 3. Similar results were found with other resistant strains.

An indication that DDE is not the only decomposition product formed in some cases is given by attempts to account for all applied DDT. With survivors from the resistant strains, the sum of external DDT, internal DDT, internal DDE calculated back to DDT, plus these compounds excreted or brushed off in the container usually was at least a third less than the amount of DDT originally applied.

The conversion of absorbed DDT to DDE may be an enzymatic process, for flies first killed by heating in air at 80° C for a few minutes absorbed large amounts of DDT but converted none to DDE.

Work on this problem is continuing and will be reported on more fully later.

Biosynthesis of Radioactive Vitamin B_{12} Containing Cobalt[60]

Louis Chaiet, Charles Rosenblum, and David T. Woodbury[1]

Merck and Company, Inc., Rahway, New Jersey

Vitamin B_{12} obtained from liver extracts (*6, 9, 11*) and by fermentation from *Streptomyces griseus* (*8*) has been characterized as a cobalt complex (*1, 7*). In a paper by Hendlin and Ruger (*3*), it has been shown that the production of LLD activity and vitamin B_{12} can be increased during fermentation processes by the addition of small amounts of cobalt ions. The addition of radioactive cobalt to a broth inoculated with *Streptomyces griseus* should yield radioactive vitamin B_{12}. Fermentations[2] conducted with this organism using a broth to which cobalt[60] sulfate[3] had been added actually have yielded vitamin B_{12} containing radioactive cobalt. The vitamin content of the vitamin B_{12} concentrate was evaluated by means of an 8-stage countercurrent distribution, using the system benzyl alcohol-water.[4] In addition to measuring color intensities in the several tubes, the β-radioactivity of aliquots was determined by means of a thin window counter, employing evaporation residues in steel planchets. The counting efficiency of our equipment was $\simeq 6\%$. Activities are reported as measured, i.e., without efficiency corrections.

Preliminary experiments were undertaken to ascertain the feasibility of preparing the radioactive vitamin by fermentation. For this purpose radioactive cobalt, having a specific activity of 1.94×10^5 cpm/mg was added to a fermentation broth at the level of 2 ppm. After fermentation, isolation, and partial purification, a vitamin B_{12} solution with a total activity of 2000 cpm was obtained which was analyzed spectrophotometrically and by countercurrent radioactivity distribution. The vitamin B_{12} content of this solution equivalent to the observed intensity of the 5500-A band (*1, 2*) was computed to be 0.147 mg vitamin B_{12} or 6.6 µg Co (*7, 10*) and therefore would be expected to have a maximum activity of 1280 cpm if added cobalt were utilized preferentially by the organism. This would indicate that the radioactive vitamin B_{12} constituted not more than $\frac{1280}{2000} \times 100$, or 64% of the product (if all radioactive components were of approximately equal molecular weights). The material available was insufficient for a countercurrent color distribution. From countercurrent radioactivity distribution analysis, however, it was ascertained that 19% of the total activity concentrated in the fourth tube as compared to a theoretical value of 29% for pure vitamin B_{12}. This analysis indicates that a maximum of $\frac{19}{29} \times 100$, or 66% of the radioactive cobalt was present as vitamin B_{12}, which maximum agrees with the value of 64% computed from the spectrophotometric determination. The agreement between the maximum vitamin B_{12} contents calculated by these independent methods in experiments of this type clearly pointed to the formation of radioactive vitamin B_{12}.

A subsequent experiment, performed with cobalt of higher specific activity, permitted the isolation of $\simeq 0.5$ mg of once-crystallized vitamin. The visual appearance of these radioactive crystals was similar to that of normal vitamin B_{12}, and the spectrum in aqueous solution exhibited all the absorption bands (*1, 2*) reported for the nonradioactive product, despite the presence of another absorbing component. The presence of activity in the

[1] The authors are greatly indebted to Robert G. Denkewalter and George B. Hughey for their interest in this work.

[2] Fermentations were performed under the supervision of E. O. Karow and B. L. Wilker.

[3] The radioactive cobalt sulfate was obtained from Tracerlab, Inc., on allocation from the Isotopes Division, U. S. Atomic Energy Commission.

[4] A manuscript including details of this analytical method is in preparation and will be published separately by F. A. Bacher *et al.*

crystals was confirmed by means of the radioautograph technique.

The yield of crystalline material was sufficient to permit a countercurrent analysis for vitamin B_{12} content based both on color (5500-A band intensity) and on radioactivity distribution. The fraction of total color distributed in the fourth and fifth tubes, where vitamin B_{12} concentrates, was equal within experimental error to the fraction of total radioactivity found in these tubes. This correspondence between color and radioactivity definitely establishes the identity of the radioactive vitamin B_{12} with the normal vitamin. The intensity of absorption at 5500 A in the fourth and fifth tubes amounted to 22% and 19% of total, and the corresponding radioactive cobalt content was 23% and 18.2%, respectively, as compared to theoretical values of 29% and 24.7% for the pure vitamin. Color distribution results thus indicate a purity of 76% for both tubes, while the activity measurements show that 79% and 73% (average 76%) of the radioactive cobalt is present as vitamin B_{12}. As judged by the color and activity distributions and the absorption spectrum of the crystals, the second component (also radioactive) appears to be largely vitamin B_{12a} (*4*) or vitamin B_{12b} (*5*).

TABLE 1

COUNTERCURRENT DISTRIBUTION OF CRYSTALLINE RADIOACTIVE VITAMIN B_{12}

Tube	Water phase % of total		Benzyl alcohol phase % of total	
	Color	Activity	Color	Activity
1	1.9	2.5	1.1	1.0
2	5.9	6.2	4.6	4.2
3	11.7	11.4	9.8	10.0
4	14.6	15.3	12.9	12.5
5	11.9	12.1	10.6	10.2
6	6.4	5.6	5.4	5.2
7	1.4	1.5	1.6	1.7
8	(0.1)	0.2	(0.1)	0.4

In view of this preliminary investigation, larger scale fermentations were conducted and about 100 mg of high purity, crystalline, radioactive vitamin B_{12} was isolated. The absorption spectrum of the product was characteristic of the normal vitamin in all its detail (*1*, *2*) and indicated a vitamin B_{12} content of 97%. The results of an 8-stage countercurrent distribution analysis are reported in Table 1, which lists the percentage of total color and of radioactivity found at each stage and in both phases.

This distribution of radioactivity is identical within experimental error with the color distribution and corresponds closely with that expected for vitamin B_{12}, thus definitely establishing that the preparation is truly radioactive vitamin B_{12}. The activity of the present crystalline product is $\simeq 0.25$ μc/mg. By starting with cobalt sulfate of higher specific activity than employed in this work, radioactive vitamin B_{12} of much higher specific activity than 0.25 μc/mg can be produced.

References

1. BRINK, N. G. *et al.* *J. Amer. chem. Soc.*, 1949, **71**, 1854.
2. ELLIS, B., PETROW, V., and SNOOK, G. F. *J. Pharm. Pharmacol.*, 1949, **1**, 160.
3. HENDLIN, D. and RUGER, M. L. *Science*, 1950, **111**, 541.
4. KACZKA, E., WOLF, D. E., and FOLKERS, KARL. *J. Amer. chem. Soc.*, 1949, **71**, 1514.
5. PIERCE, J. V. *et al.* *J. Amer. chem. Soc.*, 1949, **71**, 2952.
6. RICKES, E. L. *et al.* *Science*, 1948, **107**, 396.
7. *Ibid.*, **108**, 134.
8. *Ibid.*, 634.
9. SMITH, E. L. *Nature*, Lond., 1948, **161**, 638.
10. *Ibid.*, **162**, 144.
11. SMITH, E. L. and PARKER, L. F. J. *Biochem. J.*, 1948, **43**, viii.

Culturing *Crepidula plana* in Running Sea Water

Harley N. Gould

Newcomb College of Tulane University, New Orleans

The simple method of culturing *Crepidula plana* described here is designed to prevent waste of material and lessen the expense of collection at seaside laboratories, where the eggs of this small gastropod are in demand for embryological work.[1]

The shells of hermit crabs may contain attached communities of *C. plana* numbering several dozens of individuals of all sizes and sexual phases from tiny spat to old females. Immature specimens and males are more numerous and are usually discarded and lost, although they are all potential egg-producers. If all the individuals are detached and transferred to 4-in. finger bowls under running sea water they will attach themselves to the glass, and the young will grow to maturity and provide eggs, requiring no more attention than an occasional dumping of debris from the bowls.

At Woods Hole, males removed from the communities in June and cultured may reach the adult female phase by the end of August. Small spat, 2–5 mm in length, may not produce eggs until the next summer season, but these animals survive the winter with very low mortality. The natural tendency to community sex adjustment in *C. plana* insures that any artificial community, unless it consists exclusively of adult females, will eventually contain both sexes. It is immaterial whether it is started with sexless young, immature males, adult males, regressive males, or any mixture of these phases. Adult females should be accompanied by small individuals which will develop the male phase and fertilize the eggs.

The number of individuals which may be cultured in one dish is limited only by the area available for attachment and growth. Dense crowding limits size and increases the proportion of males. A continual movement of unfiltered sea water over the animals is important, since it provides the microscopic food organisms necessary. A stack of finger bowls separated by squares of coarse galvanized iron wire netting, with the sea water

[1] Other workers have conducted laboratory experiments on a related species.

running into the top bowl and trickling down to those below, has proved successful and economical of space. As maturing females lay eggs, the clusters can be seen through the glass. The females may be detached, the eggs removed, and the animals replaced to lay again. (Conklin in Galtsoff *et al.* [*2*]).

Growth and sexual activity are reduced to a minimum at temperatures below about 15° C. It is possible that reproduction might be induced during the winter if running sea water were warmed as described by Loosanoff (*3*).

References

1. Coe, W. R. *J. exp. Zool.*, 1936, **72**, 455.
2. Galtsoff, P. S. *et al.* *Culture methods for invertebrate animals.* Ithaca, N. Y.: Comstock Pub. Co., 1937.
3. Loosanoff, V. L. *Science*, 1949, **110**, 192.

Egg Capsules of River Limpet Snails: Material for Experimental Biology

Poul Bondesen[1]

Laboratory of the Natural History Museum of Aarhus, Denmark

In the literature of experimental embryology and sexual physiology there are only a few reports of studies made on representatives of pulmonate gastropods. During the last few years, Raven and his co-workers at the University of Utrecht, Holland, have made a comprehensive investigation of the development of the pond snail, *Lymnaea stagnalis* L. (*8*), to get a better insight into the determination processes in animals with so-called mosaic development. In order to make a detailed analysis, the Dutch scientists at first studied oviposition and normal development. Further, some preliminary experiments were carried out on the earliest stages of development of the egg.

In 1941, I began to study the transparent egg capsules of fresh-water pulmonate gastropods. By 1942 the capsule of the patelloid *Ancylus fluviatilis* Müller had proved particularly useful in studying embryonic development.

The egg capsules of *Ancylus fluviatilis* Müller and *Ancylus fuscus* C. B. Adams are almost unknown. As it is impossible to remove the capsules without injury from the substratum, only a few superficial descriptions and exceedingly primitive sketches are to be found in the literature (*2–6*). By following a special technique, it is now possible to describe in detail the capsules of pulmonate gastropods in fresh water.

The breeding season of *Ancylus fluviatilis* Müller extends from April to the middle of August. The capsules are laid on the undersides of stones mostly in running streams, but sometimes in lakes with flowing water. The form of the capsule is very well suited for such a habitat, being slightly domed and sloping a little more toward one side (Fig. 1). Like all other capsules laid by pulmonate gastropods in fresh water, the *Ancylus* capsule is transparent, and all phases in the development of the embryo can be followed easily. During the laying of the capsule the animal rotates so that the capsule becomes a spiral, in which the terminal point overlaps the initial one (Fig. 1), in a way similar to that of *Planorbis*.

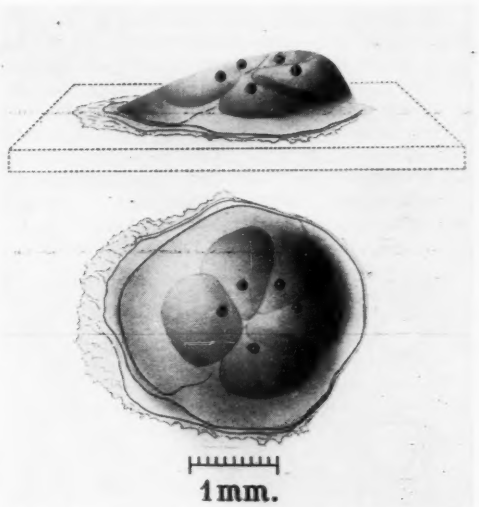


FIG. 1. Egg capsule of *Ancylus fluviatilis* Müller spawned on a glass slide in a wire-netting container. Upper: side-view. Lower: top view. Egg No. 1 is situated farthest to the left just above the initial point. The outermost irregular outline of the capsule limits the secretion from the foot gland, the quaternary envelope. The lid opens to the right along the farthest of the two side-running lines. The hinge of the lid is where the terminal part covers the initial point of the capsule (to the left on the figure).

As shown by the author in a more detailed paper (*1*), it is possible to classify nearly all pulmonate-gastropod capsules in the following way: Snails with the genital aperture on the right side will lay capsules turning to the left (counterclockwise) as in *Lymnaeidae*. Those with the genital aperture on the left side will turn in the opposite direction (clockwise) as in *Physidae*, *Planorbidae*, and *Ancylus*. The terminal point of a capsule, as a rule, is elongated into a thin tail (*exitus terminalis*), and it is accordingly possible to orient a capsule in the correct way and define the beginning and the end of the egg mass. With the pulmonate gastropods, however, it is very difficult in most cases to number the eggs in the order of their appearance.

Ancylus fluviatilis Müller and related forms, e.g., *Ancylus fuscus* C. B. Adams, are the only species in which it can be precisely determined which egg is laid first, second, etc., since the eggs are always in one row. It is useful, when determining the kind of abnormality of an egg or its content, to designate the ordinal number for each egg in the series.

[1] My thanks are due to Mr. Percy G. Bird, Aughton, Lancs., England, and Prof. A. G. Huntsman, Department of Zoology, University of Toronto, Canada, for their suggestions.

The capsule of *Ancylus fluviatilis* Müller is typical of a sessile gastropod inhabiting a locality exposed to strong water currents (cf. egg mass of *Acmaea testudinalis* Müller [7]). In such forms the eggs are placed in one layer fastened to the substratum by a special membrane. This quaternary envelope (in addition to the three formed by the egg cell, by the follicular epithelium, and by the efferent duct) within the mollusc is observed for the first time in these patelloid snails and proves to be a product of the foot gland. From 25 to 30 days after spawning, the larvae hatch through a preformed opening in the top of the capsule, a special structure found in the *Planorbidae* and *Ancylus fluviatilis* Müller, and made by an impression of the foot during capsule formation.

In the laboratory, spawning takes place at a water temperature of 10°–12° C. The snail is usually ready for spawning a short time (8–10 days) after arrival at the laboratory. Only a few capsules (4–7), each containing from 1 to 10 eggs (averaging 2.6 eggs), are laid by an individual snail during a reproductive period.

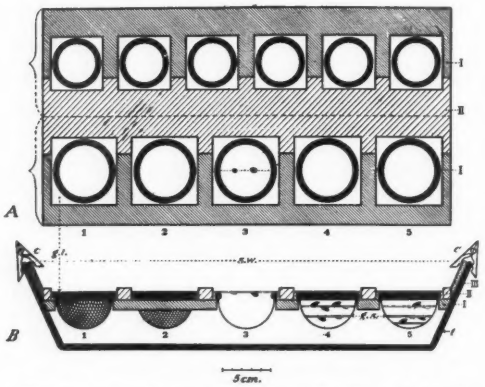


FIG. 2. Apparatus for observing oviposition of *Ancylus fluviatilis* Müller. *A*: Top view. I—Teak plates carrying wire-netting containers. II—Teak bar for fastening the glass lids, *g.l.* *B*: Longitudinal section. 1 and 2—The wire-netting containers hanging in the teak plate. 3—Median section with a specimen and an egg capsule on the glass lid. 4 and 5—Tangential section showing snails and capsules on glass slides resting on the walls of the strainers. III: Diagonal list which, by means of a clothespin, *c*, fastens the apparatus in the tray, *t*; *s.w.*—surface of current of running water.

The best results are obtained when specimens are placed in a special apparatus, shown in Fig. 2. The principle of this apparatus is to force the snails to oviposit on glass in order to get living preparations for microscopic examination. The apparatus is so constructed that the specimens will be able to spawn only on the thin glass plates, which can be easily cut into suitable pieces. In rectangular teak plates, 11×43 cm, a series of regular circular holes is cut, into which wire-netting containers (strainers) in two sizes (diam 6.5 cm and 5.3 cm) are fitted. In these containers pieces of glass slides are placed in two or three tiers resting horizontally on the rounded, sloping slides of the strainers.

TABLE 1

Number of abnormal eggs and egg cells	1943	1944	1945
	47	97	117
	%	%	%
Dwarf eggs, normal developed egg cell ...	32	19	25
Dwarf eggs, undeveloped egg cell	6	5	1
Dwarf eggs, without egg cell	28	37	5
Normal egg, undeveloped egg cell	6	13	24
Normal egg, without egg cell	13	11	23
Crushing of egg cell	5	5	8
Egg with two egg cells	2	6	3
No egg but egg cell	2	2	8
Neither egg nor egg cell (empty capsule) .	6	0	2
Gigantic egg	0	2	1

Finally, the teak plates with the strainers hang down into a deep tray (a dissecting tray), *t*, in a current of running water. In order to prevent the wooden apparatus from floating, it has to be fixed to the end walls of the tray.

By standing the apparatus in the laboratory sink, it is possible to move a long-armed binocular microscope over the horizontal glass lids and so observe the spawning and other biological habits of the animals. For studying egg capsules under the microscope, the small glass slides with capsules on them, identified by numbers scratched on by means of a glass cutter or a diamond, are put into a Petri dish half-filled with water.

For experiments with capsules under different conditions, the glass slides can be put into special small Petri dishes. Instead of running water, air is conveyed through tubes to each Petri dish, where it is released in the form of bubbles to freshen the water and provide a steady circulation.

TABLE 2

POSITION OF DWARF EGGS COMPARED WITH OTHER EGGS WITHIN THE CAPSULES OF *Ancylus fluviatilis* MÜLLER

Position in the capsule	Frequency			Avg
	1943	1944	1945	
	%	%	%	%
No others	16	14	18	16
Beginning	19	20	34	24
Middle	0	0	0	0
End	65	66	48	60

Finally, for studying egg cells and embryos in capsules, the glass slides are placed in such a way that the capsule hangs inverted in a small cell or chamber with water. Hanging-drop slides can be used for this purpose, but it is better to use a glass ring mounted on a glass slide, forming a chamber filled with water.

The egg (egg cell + perivitelline fluid and *membrana interna*) of *Ancylus fluviatilis* Müller has been shown to be the biggest, in comparison with the size of the adult, among the eggs of fresh-water pulmonate gastropods. Only the eggs of the much bigger *Planorbis corneus* L. and *Myxas glutinosa* Müller are slightly larger in absolute size, and those of *Lymnaea stagnalis* L. are about the same size. My experiments have shown that a

larger amount of albumen at the disposal of the embryo is of special value in giving it a better start in life outside the capsule.

Three years of laboratory culture of *Ancylus fluviatilis* Müller have shown that this species has a higher percentage of abnormalities (20%) in the eggs than any other species examined. The frequency of the different kinds of abnormal eggs and egg cells is shown in Table 1.

Most common in all three years are dwarf eggs, smaller than ordinary size (1.42 × 1.20 mm). Dwarf eggs may be a phenomenon definitely connected with the starting or stopping of oviposition. In both series of eggs, those throughout the egg-laying period and those in a single capsule, dwarf eggs are found mainly at the end of each series, but partly at the beginning. The percentages in which they occur in different positions within the capsules are given in Table 2.

The considerable number of dwarf eggs and other irregularities given in Table 1 also make *Ancylus fluviatilis* Müller an interesting subject for studies of the earliest phases of embryonic development. Even when still *in ovo* the embryos may meet with various influences that interfere with their normal development—e.g., variations in the quantity of albumen, crowding because of abnormal development of a neighboring embryo or accidental formation of "nurse eggs" (competition), or abnormal development of the egg cell itself, determined by intrinsic factors (e.g., lack of fertilization) or extrinsic factors (e.g., crushing of the egg cell during the formation of the capsule).

The advantages of the egg capsules of *Ancylus fluviatilis* Müller as experimental material can be summarized as follows. The limpet is a suitable animal for studying oviposition and embryogenesis under laboratory conditions. The apparatus described makes it possible to obtain living eggs, laid in transparent capsules, for microscopic investigation of living preparations. The capsule is easily turned, and the eggs can be studied in series exactly in the order in which they were laid. The frequency of abnormalities of several sorts in the eggs make the capsules particularly well suited for studies of cell physiology and other aspects of experimental biology.

References

1. Bondesen, Poul. *Natura Jutlandica*, 1950, 3.
2. Clapp, W. F. *Occ. Pap. Boston Soc. nat. Hist.*, 1921–31,
3. Moquin-Tandon, A. *Histoire naturelle des mollusques terr. et fluv. de France.* Paris: J. B. Bailliere, 1855. Vol. 2, pp. 481–86.
4. Oldham, C. *J. Conch.*, 1933, **19**, 330.
5. Percival, E. and Whitehead, H. *J. Ecology*, 1929, **17**, 282.
6. Pfeiffer, C. *Naturgeschichte deutscher Land- und Süsswasser-Mollusken.* Weimar: Industrie Comptoir, 1821.
7. Willcox, M. *Amer. Nat.*, 1905, **39**, 325.
8. Woerdeman, M. V. and Raven, Chr. P. *Exp. Embryol.*, 1946, **64**.

Presence of Iodinated Amino Acids in Unhydrolyzed Thyroid and Plasma[1]

J. Gross, C. P. Leblond, A. E. Franklin,[2] and J. H. Quastel

Department of Anatomy, McGill University,* and *Research Institute, Montreal General Hospital

De Robertis (*1*) demonstrated the presence of a proteolytic enzyme in the colloid of the thyroid follicle. He postulated that this enzyme causes the breakdown of thyroglobulin with the release of biologically active fragments which are of low enough molecular weight to diffuse out of the follicle, and which presumably constitute the thyroid hormone. The only compound of small molecular weight found so far in unhydrolyzed thyroid is thyroxine (*4*). In the present work, the technique of paper chromatography has been used to confirm this result, and to study the production of other iodinated amino acids which might be formed during the breakdown of thyroglobulin. The appearance of these substances in the circulation has been studied by observing their presence in *n*-butanol extracts of plasma. In addition, chromatographic analysis of whole plasma has supplied evidence as to the nature of the circulating thyroid hormone.

Methods. Female albino rats weighing 150–200 g and maintained on Remington's low iodine diet No. 342 (*5*), to which 10% brewers' yeast had been added, were injected subcutaneously with about 100 μc of carrier-free radioactive iodide (NaI^{131}). After 48 hours the animals were anesthetized with ether and exsanguinated with a heparinized syringe via the inferior vena cava.

Chromatography of n-butanol extracts of thyroid and plasma. The thyroids were removed immediately, ground in 1 ml of ice-cold saline in a chilled mortar, and extracted three times with an equal volume of *n*-butanol. Similarly, the plasma was extracted three times, first with a double volume and then twice with an equal volume of butanol. In both cases, the combined butanol extracts were reduced to dryness *in vacuo* at room temperature. The dry residue was taken up in distilled water, 0.1 ml and 0.2 ml being used for the thyroid and plasma residues, respectively.

Aliquots of 0.02 ml of this solution were then chromatographed by the capillary ascent method of Williams and Kirby (*10*), with or without the addition of 20 μg of each of the following carriers: DL-thyroxine, DL-diiodothyronine, DL-diiodotyrosine, and DL-monoiodotyrosine. The aliquots were placed in the lower left-hand corner of 10 in. × 12 in. Whatman No. 1 filter paper sheets and

[1] Carried out in part with the aid of a grant from the National Research Council of Canada to C. P. Leblond, and in part with the help of a grant from the National Cancer Institute of Canada to J. H. Quastel. The help of Mrs. J. Dougherty and Miss J. Cambron is acknowledged. We are indebted to Dr. R. Pitt Rivers for the monoiodotyrosine and to Hoffman-LaRoche, Ltd. for the other iodinated amino acids used in this study.

[2] Canada Packers Research Fellow, McGill University.

dried. The developing solvent used for the first dimension was the upper layer obtained after shaking *n*-butanol with 2*N* formic acid in a separatory funnel. For the second dimension, the upper layer of a mixture of 4 parts *n*-butanol and 1 part dioxane shaken with 5 parts of 2*N* NH_4OH was used. After overnight development for each dimension, the papers were removed and dried in a current of air. They were then applied to Eastman No-Screen x-ray film, with a sheet of cellophane intervening, and thus exposed for varying periods of time. The duration of exposure depended on the activity present, as determined with a Geiger probe monitor. After autography (Figs. 1–3) the papers were dried for 30 min at 100° C, sprayed with ninhydrin (0.1% solution in $CHCl_3$ with the addition of 0.1% collidine), and dried at 100° C again. The colors obtained with ninhydrin were rather pale, but were sufficiently clear to locate the added carrier amino acids. By this technique it was possible to obtain a complete separation of the four iodinated amino acids and of iodide as well.

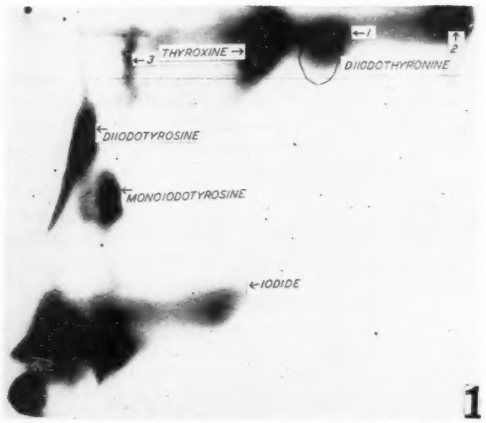


FIG. 1. An autograph of a two-dimensional chromatogram of the entire butanol extract of the fresh thyroid taken from an adult rat given 100 μc of carrier-free NaI^{131} subcutaneously, 48 hr previously. Twenty μg each of nonradioactive DL-monoiodotyrosine, DL-diiodotyrosine, DL-thyroxine, and DL-diiodothyronine were added to the butanol extract. The paper was developed vertically with a butanol-formic acid mixture and horizontally with a butanol-dioxane-ammonia mixture. The material was deposited on the left lower corner. Some spots are due to thyroxine, diiodotyrosine, monoiodotyrosine, and iodide; others are due to unidentified substances indicated by the numbers 1, 2, and 3.

Chromatography of the plasma proteins. The plasma proteins, combined with hemin in the manner described by Franklin and Quastel (*2*), were chromatographed at pH 7 using M/20 citrate buffer in the first dimension and M/20 phthalate buffer in the second dimension. Two hours were allowed for a satisfactory development in each dimension. After the paper had dried, the benzidine reagent was applied with a small paint brush, resulting in the formation of a blue color at the site of the plasma protein. The results were photographed immediately.

This method was used with radioactive plasma obtained from the radioiodide-treated rats described. Plasma

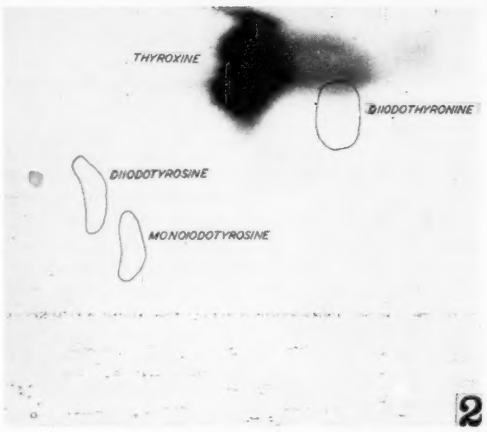


FIG. 2. An autograph of the entire butanol extract of 2.5 ml of the plasma of the same animal as in Fig. 1; the same carriers were added. An intense thyroxine spot is visible. The much less intense spot next to it is probably due to the substances causing spot 1 in Fig. 1.

(0.02 ml) was applied directly to the paper. After the two-dimensional chromatography, the paper was placed in contact with an x-ray film for autography (Fig. 5) and then treated with benzidine for localization of the proteins (Fig. 4).

The remaining plasma was extracted with butanol, and the butanol was divided into two portions which were dried in the usual manner. The first portion was dissolved in 0.1 ml of 4% NaCl, of which 0.01 ml was chro-

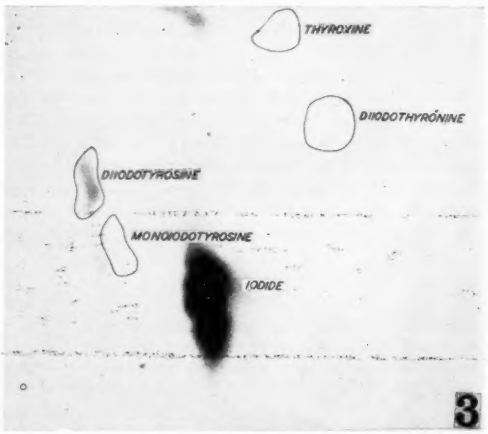


FIG. 3. An autograph of a control chromatogram of a mixture containing carrier-free NaI^{131}, and 20 μg each of nonradioactive DL-monoiodotyrosine, DL-diiodotyrosine, DL-thyroxine, and DL-diiodothyronine. Besides an intense spot due to iodide, a faint spot is visible in the location of diiodotyrosine. Two spots due to unidentified substances are also present. When the marked intensity of the iodide spot is compared with the low intensity of all other spots, it is apparent that only a very small percentage of the iodide present exchanged with diiodotyrosine and none at all with thyroxine.

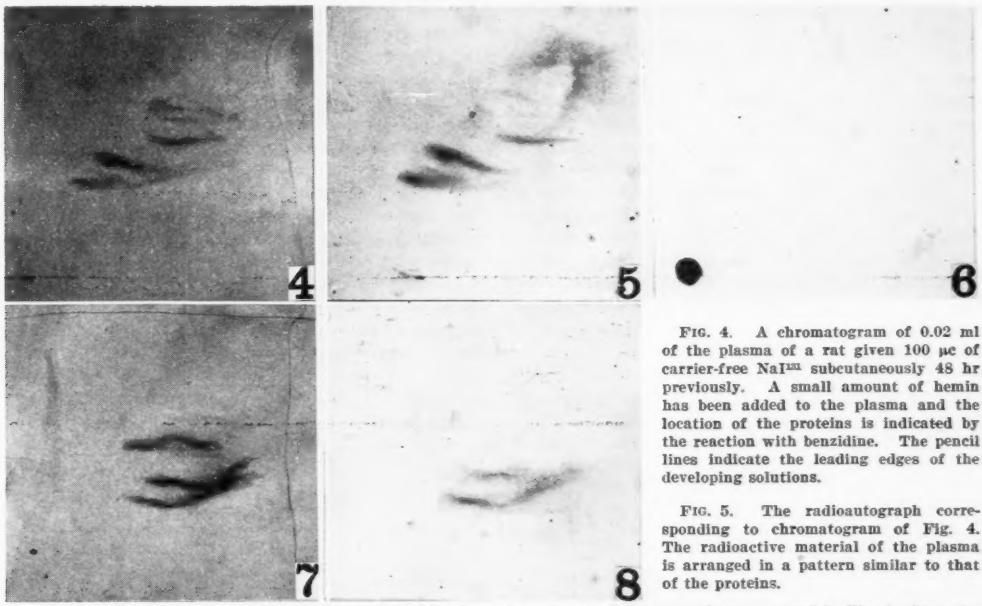


FIG. 4. A chromatogram of 0.02 ml of the plasma of a rat given 100 μc of carrier-free NaI^{131} subcutaneously 48 hr previously. A small amount of hemin has been added to the plasma and the location of the proteins is indicated by the reaction with benzidine. The pencil lines indicate the leading edges of the developing solutions.

FIG. 5. The radioautograph corresponding to chromatogram of Fig. 4. The radioactive material of the plasma is arranged in a pattern similar to that of the proteins.

FIG. 6. The radioautograph of the butanol extract of another aliquot of the same plasma as used in Fig. 4, chromatographed with buffers as in Fig. 4. By the method used in Fig 2, this extract was found to consist wholly of radioactive thyroxine. The radioactive thyroxine did not move from the origin.

FIG. 7. A chromatogram of 0.02 ml of nonradioactive plasma, to which hemin had been added and combined with an aliquot of the butanol extract used in Fig. 6, chromatographed with buffers as in Fig. 4, and sprayed with benzidine. The protein pattern is apparent.

FIG. 8. The radioautograph corresponding to chromatogram of Fig. 7. The radioactive thyroxine added to nonradioactive plasma has moved with the proteins, giving a picture similar to that obtained with radioactive plasma (see Figs. 4 and 5).

matographed with the butanol developers and autographed. Another 0.01-ml aliquot was chromatographed with buffers and autographed (Fig. 6). Finally, the second portion of dried butanol extract was dissolved in nonradioactive plasma obtained from another rat, mixed with hemin, chromatographed with buffers (Fig. 7), and autographed (Fig. 8).

Confirmatory experiments with plasma proteins not containing hemin were carried by the addition of nonradioactive DL-thyroxine. Thyroxine (100 μg) was mixed with 0.02 ml radioactive plasma, chromatographed with buffers and the location of thyroxine determined by spraying with ninhydrin.

Identification of components. Thyroid and plasma fractions of ten animals were chromatographed and autographed. The autographs (Fig. 1) of the butanol extract of thyroid, with added carriers, showed the presence of spots corresponding to monoiodotyrosine, diiodotyrosine, thyroxine, and iodide; all of which were found in the ten animals investigated. These spots were similar in location and intensity when no carrier was used, and therefore the presence of these substances cannot be due to an exchange between the labeled iodide and the carriers. This was borne out by control experiments in which tracer iodide was chromatographed with carriers (Fig. 3). In addition, several compounds, whose identities are unknown, were found more or less regularly throughout the series of thyroid chromatograms. Thus, of the unknowns marked 1, 2, and 3 (Fig. 1), compound 1 was found in ten and the other two compounds in seven of the preparations.

Thyroxine made up the greater part of the radioactivity of the butanol extract of plasma (Fig. 2). By using the entire plasma extract and exposing for a long period of time, it was possible to distinguish faint spots corresponding to iodide in five plasma samples and to diiodotyrosine in six. Both substances were found together in extracts of five samples of plasma. The results were identical whether or not carriers were added to the plasma extract.

A possible source of error lay in the production of artifacts by the radiochemical effect of the large doses of radioactivity used. However, it could be demonstrated that the same amino acids were present in thyroid and plasma of two rats in which radioactivity of the injected radioiodide was only 1 μc, a dose which has been shown to have no effect on the physiological processes of the thyroid (7). A very long exposure had to be used to detect the minute amounts of radioactivity present in the chromatographic spots obtained under these conditions.

Nature of the circulating thyroid hormone. When an aliquot of whole plasma from an animal given radioactive iodide was mixed with hemin and chromatographed using buffer solutions for development, the distribution of the

proteins, as shown by the benzidine reagent (Fig. 4), corresponded to the location of the plasma radioactivity (Fig. 5), indicating that the radioactivity had moved with the plasma proteins. When the radioactivity extracted by butanol was chromatographed with butanol developers, it proved to consist almost exclusively of radiothyroxine. However, when chromatographed with buffers, this radiothyroxine remained at the origin (Fig. 6). Nevertheless, if the radiothyroxine was added to nonradioactive plasma, it was displaced (Fig. 8) along with the plasma proteins (Fig. 7), in a manner similar to that of the original radioactive plasma (Figs. 4 and 5).

The same results were obtained when nonradioactive thyroxine was chromatographed with plasma that did not contain hemin, indicating that presence of hemin was not necessary for plasma-thyroxine combination.

Interpretation. These results demonstrate that, besides thyroglobulin and iodide, the thyroid gland contains small amounts of monoiodotyrosine, diiodotyrosine, and thyroxine (Fig. 1). It has been shown that the presence of these amino acids is not due to exchange phenomena (Fig. 3) or to radiochemical action. The presence in the thyroid of these amino acids, which are known to be components of thyroglobulin, lends support to the hypothesis that thyroglobulin undergoes proteolysis by the enzyme described by De Robertis (*1*).

The thyroxine found in plasma is most likely of thyroid origin. This is indicated by experiments showing that the butanol-soluble radioactivity of plasma is extremely low in thyroidectomized rats (*3*). The passage of thyroxine into the circulation has been previously explained by a gradient of thyroxine concentration in thyroid tissue and plasma (*4*). It may be pointed out further that the diffusion of thyroxine from the thyroid would tend to correct the increase in osmotic tension due to proteolysis in the colloid. The failure to find significant amounts of the other iodinated amino acids in plasma may be explained by their destruction within the follicle and a reutilization of their iodine by the gland.

In the plasma, thyroxine has been found combined with proteins. This combination may be severed easily by butanol, but is reconstituted when thyroxine is placed in contact with plasma proteins (Figs. 7 and 8). Furthermore, since plasma proteins may combine with amounts of thyroxine well above the physiological doses (100 μg in 0.01 ml), it may be assumed that under physiological conditions the thyroxine secreted from the thyroid combines with plasma proteins as it is released.

The nature of the thyroxine complex in plasma is obscure. However, iodine has been found in the albumin fraction of plasma (*6, 8, 9*), and to a somewhat lesser extent in the globulin fraction (*6, 8*). Attempts to determine the plasma constituent which is the thyroxine carrier are currently under way.

In summary, when adult female rats on a low iodine intake were sacrificed 48 hr after an injection of carrier-free radioiodide, butanol extracts of unhydrolyzed thyroid and plasma analyzed by radioautography of two-dimensional paper chromatograms revealed the presence of six radioactive compounds besides iodide and thyroglobulin. Of these, three were identified as thyroxine, diiodotyrosine, and monoiodotyrosine. In the blood plasma, practically all the butanol-extractable radioactivity was present as thyroxine, with a very low amount of diiodotyrosine and iodide. When the whole plasma was analyzed by radioautography of two-dimensional buffer chromatograms, it was shown that the location of the radioactive material corresponded to that of the plasma proteins. Although thyroxine solutions showed no movement from the origin under these conditions, radioactive thyroxine dissolved in nonradioactive plasma was displaced along with the plasma proteins and gave a pattern very similar to that of radioactive plasma itself.

It was concluded that thyroxine, after its release by the thyroid gland, circulates in combination with plasma proteins. The complex thus formed can be split with butanol and reconstituted *in vitro*.

References

1. De Robertis, E. *N. Y. Acad. Sci.*, 1949, **50**, 279.
2. Franklin, A. E. and Quastel, J. H. *Science*, 1949, **110**, 447.
3. Gross, J. Doctoral dissertation, McGill University, 1949, p. 174.
4. Leblond, C. P. and Gross, J. *J. clin. Endocrinol.*, 1949, **9**, 149.
5. Remington, R. E. *J. Nutrition*, 1937, **13**, 223.
6. Riggs, D. S., Lavietes, P. H., and Man, E. B. *J. biol. Chem.*, 1942, **143**, 363.
7. Skanse, B. *J. clin. Endocrinol.*, 1948, **8**, 707.
8. Taurog, A. and Chaikoff, I. L. *J. biol. Chem.*, 1948, **176**, 639.
9. Trevebrow, V. *J. biol. Chem.*, 1939, **127**, 737.
10. Williams, R. J. and Kirby, H. *Science*, 1948, **107**, 481.

Xanthopterin Obtained from the Skins of the Yellow Mutant of *Bombyx mori* (Silkworm)

Y. Hirata, K. Nakanishi, and H. Kikkawa[1, 2]

Faculty of Science, University of Nagoya Chikusa-ku, Nagoya, and Sericultural Experimental Station, Taketoyo Branch, Aichi, Japan

The gene named "Lemon colored" which is present in the third chromosome of *Bombyx mori* gives rise to yellow-colored larvae instead of the white ones of the normal type. The yellow pigment exists in the epidermis and is considered to possess a close relationship with tryptophan metabolism, as in the case of the eye pigments of *Drosophila* and other insects (*4, 5*). Chemical researches made on this pigment have identified it as xanthopterin.

A hundred larvae of the yellow *lem* type in the fifth instar were dissected, the skins were denatured by treatment with alcohol, the lipochromes were extracted with ether in a Soxhlet apparatus, and the pigments finally were extracted with 200 ml and 400 ml of boiling water. The first extract gave a purple-plus-yellowish green fluorescence, and the second a purple fluorescence. The first extract was made acidic (0.05*N*) with hydrochloric acid and left overnight in an icebox, when 160 mg of white crystals was obtained. These crystals, after recrystalliza-

[1] The chemical researches of this report were carried out by Hirata and Nakanishi.

[2] The authors wish to acknowledge the helpful suggestions of Prof. F. Egami during the course of this research.

tion (accomplished by pouring water into the concentrated sulfuric acid solution), were identified as uric acid through their ultraviolet absorption spectrum[3] (absorption maximum: 280 mμ in 0.1% sodium hydroxide) and certain qualitative properties. The filtrate, together with the second 400-ml extract, was evaporated *in vacuo*, and the residue was washed with 2*N* hydrochloric acid. The properties of the insoluble portion (white crystals and powder) will be described.

The hydrochloric acid solution was evaporated *in vacuo*, water was added, and the solution was then made alkaline with ammonia, the insoluble portions being discarded each time. After final refinement by the addition of charcoal, the green fluorescent solution was submitted to paper chromatography, using the butyl alcohol-acetic acid mixture by Partridge (*6*). The bands were located by their fluorescence (*2*). Since pure xanthopterin was unavailable, paper chromatography of the wings of a pierid (*Eurema etaeta* Boisduval) known to contain xanthopterin was carried out simultaneously. Though Good and Johnson (*2*) have given 0.38 for the R_f value of xanthopterin, we have obtained a value of 0.54. The yellow pigment from *Bombyx mori* gave the same R_f value, and several qualitative properties showed it to be xanthopterin. Riboflavin also gave the same R_f value, but its fluorescence and chemical behavior were different.

It is to be noted that, when left in the sunlight for one day, both the silkworm and pierid extracts acquired a fluorescence of a bright blue tone and instead of the yellowish green band on the paper chromatogram a bright blue band with an R_f value of 0.26 appeared. Similarly, when the paper-chromatographed filter strip of the undecomposed solution was left in the sunlight, the yellowish green band changed into a band with a bright blue fluorescence. The reason for this kind of photolysis of xanthopterin is obscure and apparently has not been described in the literature.

Xanthopterin was also concentrated from the original boiling water extract, according to the method of Crammer (*1*), using liquid phenol. This solution gave a band on the paper chromatogram with a purple fluorescence (R_f: 0.50) corresponding to the pterinlike substance mentioned below, in addition to the band of xanthopterin. One hundred milliliters of water was added to the 2*N* hydrochloric acid-insoluble portion mentioned above, the rather heavy crystals (uric acid) were separated, and the remaining flocky precipitate was reprecipitated several times from boiling water. The filtrate was next dissolved in a small amount of concentrated sulfuric acid and was poured into water dropwise, when white crystals were obtained. The hot aqueous solution gave a strong purple fluorescence (R_f: 0.50).

Thus, xanthopterin, uric acid, and a minute amount of some white crystals have been obtained from the yellow mutant. This white crystal, though closely related to leucopterin, isoxanthopterin, and the purine homologue, is not identical with any of them, and seems probably to be a new pterin. The chemical researches on this substance are being carried out and will be reported subsequently. This substance is obtained in greater amount from skins of the normal type of silkworms.

Jucci (*3*) has stated that the white epidermis pigment is a urate, and Shimizu (*7*), basing his work on this view of Jucci, has made some quantitative studies of the uric acid production by means of the Folins-Denis-Wu reaction. However, since the new pterinlike substance also gives a strongly positive Folins-Denis-Wu reaction, the results of Shimizu should be g[i]ven further consideration.

We are not yet in a position to discuss the formation of epidermis pigments from a genetic point of view until the chemical structure of this substance is clarified.

[3] The authors are greatly indebted to Prof. K. Yamasaki for the measurements.

References

1. Crammer, J. L. *Nature*, Lond., 1948, **161**, 349.
2. Good, P. M. and Johnson, A. W. *Nature*, Lond., 1949, **163**, 31.
3. Jucci, C. *Proc. sixth internat. Congr. Genet.*, 1932, **1**, 377.
4. Kikkawa, H. *Advances in biology*. Tokyo: Kyoritsu Publishing Co. (in Japanese). 1948, Vol. III. Pp. 36.
5. ———. *Genetics*, 1941, **26**, 587.
6. Partridge, S. M. *Biochem. J.*, 1948, **42**, 238.
7. Shimizu, S. *Rep. sericultural exp. Sta.* (in Japanese), 1943, **11**, 379.

Processing Unit for 35-mm Color Film[1]

O. S. Gibbs and J. R. Wilder

Gibbs Medical Research Laboratory, Whitehaven, Tennessee

The advantages of 35-mm color film are of such importance that its use is steadily increasing as a means of scientific record. Color recording has its greatest value where a combination of colors and shapes is such that in each separate item changes may exist which are hardly measurable and yet which, taken together, give a very marked visual difference in the total picture. This is of course especially true of pathological changes. At the present time, however, few facilities have been created for the average worker to develop his own films. This may be necessary in cases where the original picture will disappear before commercial development is completed and thus be lost. Having to face such a problem ourselves, and finding no available answer, we were compelled to find its practical solution. As this has been rather satisfactorily accomplished, it occurred to us that others might wish to take advantage of our study.

Very briefly, we may remark that to process color film requires 13 separate operations, one being a reexposure, four being intermediary or final washing. For the commercial operator with adequate volume of work, large and expensive tanks are available, but these are of little value to the ordinary laboratory, as the cost in chemical replacement alone would be prohibitive. For the amateur there are small tanks fitted with spools on which film must be placed. After a few trials with this aggravating and inefficient apparatus, we hastily discarded it. What was needed was an intermediate arrangement that could handle one or two films per day, be economical in operation, fully and evenly expose the film to the processing

[1] Sponsored by The Dr. Geo. W. McFatrich Memorial Ophinjection of solutions A, B, C, and D.

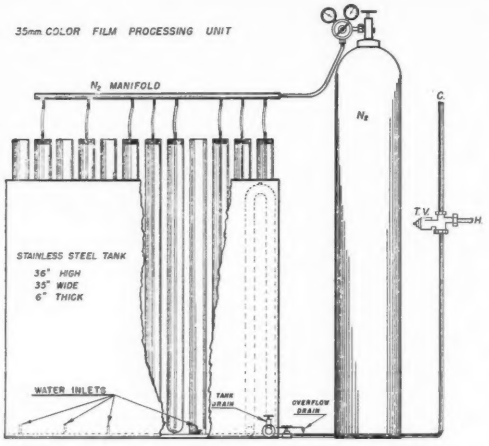


FIG. 1.

fluids, and possess the essential mechanical stirring and temperature control.

With these points in mind we built a tank (Fig. 1) from No. 26 gage stainless steel. Into this was fitted a rack, made by soldering cross bars of ⅛-in. brass rod at appropriate distances to form 12 equal compartments, with a center one to subdivide these into two. There are three layers of rods: one in the middle, the other two 1 in. from the top and 9 in. from the bottom respectively. Those holding the processing tubes are made from 52-mm (I.D.) Pyrex tubing 40 in. long. The tank is of sufficient size to take two rows of 12 tubes, so that two or even more films may be processed together. The ends of the eight processing tubes are sealed off, as we encountered trouble from bungs that work loose, especially with the alkaline solutions. The four wash tubes have a bung at the bottom through which water enters, appropriately led into the bottom of the tank. Water entering the washing tubes leaves simply by spilling over into the tank and from there it leaves by a constant level trap to the drain. The trap inlet, however, is from the bottom of the tank, so that a complete circulation is established. The water entering the wash tubes is connected to both hot and cold water supplies by a thermostatic valve set at 68° F and thus serves to maintain a reasonably constant temperature not only of the wash water but also of the entire processing tank and contained tubes.

Above the tank is an appropriately arranged manifold of copper tubing with 16 outlets, one for each processing tube. Each outlet is simply connected by rubber tubing to a 41-in. length of 1- to 2-mm Pyrex capillary tubing that goes through the bung to the bottom of the process tube. Simple screw clamps are on each supply. These tubes pass through the bung eccentrically, so that when in use they can be twisted backwards clear out of the way of the film, but still conveniently rest on the edge of the process tube. To this arrangement is connected a tank of nitrogen, which by bubbling from the bottom of the process tubes effectively stirs the contents and has the not-looked-for advantage of keeping the uptake of incidental oxygen to a minimal value. In consequence of this, developers remain remarkably clean and fresh, but they are replaced regularly at the end of each two-week period, since their cost is small in view of the danger of losing a valuable record.

In order to facilitate the actual operation we have also an overhead gear consisting of a ¼-in. brass rod supported on brackets on which a small overhead pulley runs the full length of the tank. Over the pulley is a cord on one end of which is a stainless steel photo clamp (Ansco), and on the other a suitable brass ring, which is prevented by a stop from passing too far over the pulley. (The first part of the process is in absolute darkness and equipment must be readily handled by feel.) Situated directly opposite the correct tube in the series is a floodlight arranged on a suitable folding bracket which, when pulled forward, is exactly the correct distance from the suspended film. This completes the setup. All that is now needed is a vociferous time-interval clock with handles suitable for operation in the dark.

The actual processing is very simple. First, the water is turned on and its temperature is checked. The nitrogen commences bubbling through the first three baths (performed in total darkness). The light is turned off, and the film is fastened by one end to the overhead gear. At the other end is fastened a similar stainless steel clamp loaded with 20 g of bar solder, to keep the film from waving too freely even with excessive bubbling. The film is lowered into the first developing tube, and the clock is turned on. At the proper time, the film is pulled from the tube by the ring and lowered into the second tube, and the timing is repeated. After the processing in the third tube, lights may be turned on, and the remainder of the process may be carried on in ordinary light. At the appropriate time the film is reexposed. This is accomplished by hauling it clear from the tube, which is so arranged that it is exactly opposite the floodlight. Finally, after complete processing and washing, the film, still weighted, is hung up to dry.

It will be noted that the fingers never touch the film, except at the discarded ends, at any stage. We have had practically no trouble with spotting from any cause, and no trouble from uneven development or accidental contamination, although we have used this method for processing several hundred films. It may also be noted that after the dark stage, nitrogen is passed into each tube as needed, thus minimizing waste. On a regular output of one film a day the cost is little more than rent of the cylinder. Finally, when the process is over the bungs are replaced in the process tubes to keep out oxygen and dust.

Appropriate timing and technical details are omitted, since they must be acquired for the particular variety of film used. At this time the only reliable source of suitable film is Ansco, with which we have had satisfactory results. We must warn those inexperienced in color work to pay great attention to details, above all to temperature control, for the film is far less tolerant than the good-tempered material now available for black and white.

We also feel that, as film batches vary somewhat, abso-

lute color rendering is not yet really practical. Experiments should be so planned that reliance is placed on comparison of adjoining material on the same film, with no attempt to set up absolute color values. With these limitations, our experience has shown us that the advantages of color film are such as to render it a necessity for certain types of work. We have attempted color reproduction on paper, which for some purposes would be most useful, but at present we must report adversely. Color rendering is quite markedly diminished and the cost in time, of processing especially, is practically prohibitive except for limited use.

Growth Regulators Prolong the Bloom of Oriental Flowering Cherries and Dogwood

Horace V. Wester and Paul C. Marth
National Capital Parks, Department of the Interior, Washington, D. C., and Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U.S.D.A., Beltsville, Maryland

Considerable interest has been shown in the progress of experiments with growth-regulator (hormone) sprays to prolong the blossom display of the Oriental Japanese, or flowering cherries, Yoshino, *Prunus yedoensis* Matsum; Akebono, *P. yedoensis*; Kwanzan, *P. serrulata* Lindl.; and Shiro-fugen, *P. serrulata*, in Washington, D. C. These experiments have been conducted during the past two seasons (1948 and 1949) and have been extended to include a number of other woody ornamentals. Thus far the treatment has proved most effective on Oriental cherries and white flowering dogwood, *Cornus florida* L.

In 1948, individual branches on trees of the single-flowered Yoshino variety and small whole trees of the double-flowered Kwanzan cherry were used. Both varieties responded to sprays of α-naphthaleneacetic acid and β-naphthaoxyacetic acid at concentrations of 5, 10, 20, 40, and 80 ppm. Frequently 25% of the petals of sprayed flowers remained attached 4 to 10 days longer than the unsprayed. Foliage of Yoshino and Kwanzan was injured by sprays containing 40 and 80 ppm, but no injury was evident at the lower concentrations. A spray mixture containing 64 ppm of indolebutyric acid and 16 ppm of β-naphthoxyacetic acid was also effective in retarding petal fall of Yoshino, but proportionate mixtures of this combination at one-half and lower concentrations were ineffective. Another compound, *p*-chlorophenoxyacetic acid, was ineffective in retarding petal fall of the Shiro-fugen cherry at spray concentrations 5 to 20 ppm, whereas naphthaleneacetic acid at the same concentrations was quite effective.

Branches of Yoshino that were sprayed retained their petals 4 to 7 days longer than comparable unsprayed branches. During this period the sprayed petals gradually developed a more intense pink pigmentation than did unsprayed ones and the majority of the treated petals appeared fresh until they fell from the tree.

Young Kwanzan trees held their flowers for 7 to 10 days longer than unsprayed ones. The double flowers of this variety are borne on long, slender flower stalks which allow them to be whipped back and forth by the wind, thus causing some discoloration and shedding of the petals. At a distance of 10 to 15 ft the mass floral display was nevertheless fairly attractive during most of the period that the flowers remained attached, even though the petals were injured by the wind.

In another experiment, naphthaleneacetic acid spray (10 ppm) was applied at intervals during the blossoming period. The results of this test indicated that the chemical was most effective when applied as the trees came into full bloom. Treatments applied to flower buds just prior to opening were ineffective.

Over 400 Japanese flowering cherry trees were treated with the growth-regulator sprays in experiments conducted during 1949. In the Tidal Basin planting, some Yoshino and Akebono trees retained 35% to 80% of their blossoms 3 to 7 days longer than unsprayed trees, but others showed little or no response. A detailed check on the effect of naphthaleneacetic acid (10 ppm) applied to 65 large Yoshino trees on March 29–30 showed an average of 20% of the flowers present April 11, 13 days after full bloom, in comparison with 3% remaining on ten comparable unsprayed trees at this time. Direct comparison between naphthaleneacetic acid and β-naphthoxyacetic acid showed that the former compound was the more effective.

Kwanzan flowers responded more consistently to 10 ppm naphthaleneacetic acid than did the Yoshino and Akebono varieties. Thirteen days after treatment, an average of 23% of the flowers was found present on 32 large Kwanzan trees, in comparison with 4% on nine comparable untreated trees.

In addition to Japanese cherry, tests have been conducted on other spring-flowering ornamental plants. White flowering dogwood has shown a definite response in two years of testing. During the 1948 season two compounds, α-naphthaleneacetic acid and *p*-chlorophenoxyacetic acid, were applied to individual branches at 10- and 20-ppm spray concentrations. The petal-like flower bracts of dogwood remained attached 4 to 6 days longer when sprayed with either concentration of these compounds than when left unsprayed. Further tests made in 1949 indicate that *p*-chlorophenoxyacetic acid is much more effective in prolonging dogwood blossom display than is naphthaleneacetic acid; but the former compound tends to deform the young leaves at spray concentrations as low as 5 ppm. For this reason additional experimentation with sprays of lower concentration than 5 ppm is necessary to evaluate the practicability of using *p*-chlorophenoxyacetic acid on dogwood.

In tests conducted thus far, the flowers of a number of other kinds of plants have not shown a definite reduction in rate of petal fall when sprayed with α-naphthaleneacetic acid, *p*-chlorophenoxyacetic acid, or β-naphthoxyacetic acid in concentrations of 10 and 20 ppm. Among the plants used were azalea, aronia, American and Asiatic crab apples, flowering almond, flowering quince, redbud, bridal wreath spirea, lilac, star magnolia, and saucer magnolia.

Association Affairs

Preliminary Announcement of the Cleveland Meeting, December 26–30, 1950

The 117th Meeting of the American Association for the Advancement of Science, the annual meeting for the year 1950, will be a full-scale meeting—with programs in every principal field of science from astronomy and botany to, and including, zoology. All 17 of the Association's sections and subsections and more than 40 participating societies and organizations are completing plans for an aggregate of more than 200 sessions. The Annual Science Exposition, in the Arena of Cleveland's Public Auditorium, is expected to exceed that of the New York Meeting.

Nearly all of the sectional programs will be held in meeting rooms of the Auditorium, within short walking distance of the downtown hotels. Sections I (Psychology) and Q (Education), however, will meet in the Statler, headquarters of the science-teaching societies, and Section F (Zoology) probably will hold its symposium in the Hollenden, the headquarters of the four zoological societies. Except for some of the large public lectures, in the Auditorium, and demonstration sessions one afternoon on the campus of Western Reserve University, the public rooms of the hotels will serve well the requirements of the societies.

There will be a considerable number of outstanding symposia. Most of these are scheduled for the latter part of the week, whereas most paper-reading sessions of the sections will be held the first part of the period. It has been possible to keep conflicts between programs in a given field to a minimum. The individual convenience and integrity of the sessions of each society are assured by continuous use of the same rooms in hotels where related societies are housed. At the same time, the advantages of the large diversified meeting are not lost. There will be joint programs and symposia in areas between scientific fields and the bringing together of out standing authorities and workers in diverse fields of science. In the Exposition, publishers, supply houses, microscope manufacturers, instrument makers, and industrial concerns will exhibit their latest products or portray their technical accomplishments on a scale impossible at a smaller meeting in a single scientific field. Adjacent to the exhibit area will be the Main Registration, the Visible Directory of Registrants (enlarged to permit better alphabetization), the annual Photography-in-Science Salon, sponsored by *The Scientific Monthly* and the Smithsonian Institution, and the Science Theatre, this year repeating programs throughout the week in a large room designed for projection and with a capacity of 678.

The list of special sessions or public lectures, such as the AAAS Presidential Address, and those sponsored by the Academy Conference, the British Association for the Advancement of Science, National Geographic Society, Scientific Research Society of America, and the Society of the Sigma Xi, will be augmented this year by the annual lecture of the United Chapters of Phi Beta Kappa.

An extensive series of tours to museums, laboratories, and industrial plants of the Cleveland area is being arranged. Some of these will be of particular interest to chemists and are being included as a part of the program of Section C. The variety of the tours, open to all registrants, may be appreciated by consulting the section on local committees.

An outline of the sectional programs and participating societies, arranged by scientific fields, and the personnel of the local committees, follows.

Section A—Mathematics:
Symposium on applications of mathematics.

Section B—Physics:
Four sessions: a) "Fifty years of the Quantum Theory"; b, c, d) "Scientific Implications of Nuclear Phenomena in the Fields of Astrophysics, Geophysics, and Biophysics."

Section C—Chemistry:
Twelve sessions: a) two on cortisone and ACTH; b) two on ballistics; c) two on insecticides; d) one on medicinal chemistry; e) five, of general papers.

Section D—Astronomy:
Five sessions or more.

Section E—Geology and Geography:
Eleven or twelve sessions: a) two on general geology; b) two on general geography; c) two on oil geology and stratigraphy; d) one on "Earth Science for Nonprofessionals"; and joint participation in symposia of Section B, and Section O.

Section F—Zoological Sciences:
Symposium on "Genetic Aspects of Human Behavior"; another to be arranged.

Section G—Botanical Sciences:
A series of paper-reading sessions; a two-session symposium on "The Structure and Analysis of Plant Communities"; a second symposium on "The Ecological Basis of Evolution"; a third symposium on plant physiology.

Section H—Anthropology:
Five or more sessions, including symposia jointly sponsored by participating societies in this field.

Section I—Psychology:
Fifteen sessions, including a joint evening program with Section Q.

Section K—Social and Economic Sciences:
Three symposia or panel discussions: a) "Factors Determining City Growth"; b) "Growth of the Cleveland Area"; c) "Human Ecology."

Section L—History and Philosophy of Science:
Four sessions.

Section M—Engineering:
Eight sessions: a) joint program with the Cleveland Section of American Society of Mechanical Engineers; b) joint program with the Cleveland Engineering Society; c) joint program with Case Institute of Technology; d) three-session symposium on "Partnership of Industry and Science in Research," jointly sponsored by Illinois Institute of Technology, Armour Research Foundation, Mellon Institute for Industrial Research, and the Battelle Memorial Institute.

Subsection Nm—Medicine:
Four-session symposium on "Biological Effects of Radiation."

Subsection Nd—Dentistry:
Four sessions.

Subsection Np—Pharmacology:
Four sessions.

Section O—Agricultural Sciences:
Three-session symposium on "Soil Science and Its Relations to Geology and Geography," jointly with Section E.

Section Q—Education:
Seven sessions.

AAAS Cooperative Committee on Science Teaching:
Symposium on some phase of general education.

Full details of these programs, with speakers and dates, will appear in *Science* at a later date.

Societies Meeting with AAAS

B	American Meteorological Society
	Oak Ridge Institute of Nuclear Studies (joint program with the Oak Ridge National Laboratory)
E	National Geographic Society
	National Speleological Society
F	American Society of Parasitologists
	American Society of Protozoologists
	American Society of Zoologists
	Society of Systematic Zoology
FG	American Microscopical Society
	Biometric Society, Eastern North American Region
	National Association of Biology Teachers
K	American Home Economics Association
	National Academy of Economics and Political Science
	Pi Gamma Mu
L	History of Science Society
	Philosophy of Science Association
N	Alpha Epsilon Delta, Premedical Honor Society
Q	National Science Teachers Association
X	American Nature Study Society
	Foundation for the Study of Cycles
	National Association of Science Writers
	Scientific Research Society of America
	Sigma Delta Epsilon
	Society of the Sigma Xi
	United Chapters of Phi Beta Kappa

Local Committees

It would be impossible to make successful arrangements for the large and complex meetings of the American Association for the Advancement of Science, to ensure their smooth operation, to secure adequate publicity, and to finance them, were it not for the very considerable personal services of the local committees. Those who direct local activities and serve on these essential committees merit the appreciation not only of the Association but of all those who attend.

The success of the Cleveland Meeting is assured by the following committee members who already have assumed their responsibilities:

General Chairman

Charles J. Stilwell, president, The Warner and Swasey Company

Vice Chairmen

T. Keith Glennan, president, Case Institute of Technology
John S. Millis, president, Western Reserve University

Equipment and Projection Committee

Leslie E. Frye, director, Division of Visual Education, Cleveland Board of Education, *chairman*; *Charles W. Collins*, Myron T. Herrick Junior High School; *Sanford M. Eisler*, West Technical High School; *A. H. Hersh*, Western Reserve University; *Lawrence Hyman*, Nathan Hale Junior High School; *William E. Kofron*, Division of Visual Education, Cleveland Board of Education; *Ben I. Levine*, Radio Science Lessons, Station WBOE; *Joseph L. Stevens*, James F. Rhodes High School; *M. R. Webb*, Rawlings Junior High School.

Exposition Committee

James H. Rand, III, chairman; *Randolph Eide*, president, Ohio Bell Telephone Company; *Ben T. Franklin*, Cleveland Chamber of Commerce; *Bruno Gebhard*, director, Cleveland Health Museum; *George M. Humphrey*, president, M. A. Hanna Company; *Herbert C. Hunsaker*, dean, Cleveland College, Western Reserve University; *William E. Scheele*, director, Cleveland Museum of Natural History; *Warner Seeley*, secretary, Warner and Swasey Company; *Charles W. Williams*, coordinator of research, Case Institute of Technology; *Clyde T. Foster*, president, Standard Oil Company of Ohio.

Finance Committee

Allen T. Perry, procurement manager, The Harshaw Chemical Company, *chairman*; *Allen L. Billingsley*, president, Fuller & Smith & Ross, Inc.; *George S. Dively*, president and general manager, Harris-Seybold Company; *Loring L. Gelbach*, president, Central National Bank of Cleveland; *George M. Humphrey*, president, M. A. Hanna Company; *Adrian D. Joyce*, chairman of the board, The Glidden Company; *Herbert P. Ladds*, president, The National Screw and Manufacturing Company; *James L. Meyers*, president, The Cleveland Graphite Bronze Company; *Carl N. Osborne*, vice president, The M. A. Hanna Company; *Clarence M. Taylor*, executive director, The Cleveland Clinic Foundation; *Harrie S. Taylor*, president, Oglebay, Norton and Company; *John K. Thompson*, president, Union Bank of Commerce.

Publicity Committee

David Dietz, science editor, Scripps-Howard Newspapers and *The Cleveland Press, chairman; Charles Howard Allen, Jr.*, university editor, Western Reserve University; *James C. Hanrahan*, vice president and general manager, Television Station WEWS; *John B. Mullaney*, associate editor, *The Cleveland News; John F. Patt*, vice president and general manager, Radio Station WGAR; *Phillip W. Porter*, columnist and assistant Sunday editor, *The Cleveland Plain Dealer*; *Ernest E. Thum*, editor, *Metal Progress*.

Tours and Entertainment Committee

Bruno Gebhard, M.D., director, Cleveland Health Museum, *chairman*; *Russell Anderson*, Western Reserve Historical Society; *Arthur O. Baker*, Cleveland Board of Education; *William Culbertson*, Case Institute of Technology; *Howard Dittrick*, Howard Dittrick Museum of Historical Medicine; *Donald Fabel*, Fenn College; *R. H. Ferguson*, Republic Steel Company; *Patricia Ann Fraser*, Cleveland Museum of Natural History; *Charles B. Gleason*, Garden Center of Greater Cleveland; *Edwin L. Hall*, American Gas Association Laboratory; *A. B. Holton*, Sherwin Williams Company; *Waldo C. Hovey*, The Harshaw Chemical Company; *Frank Hovorka*, Western Reserve University; *L. C. Kent*, Nela Park, General Electric Company; *Gordon Klein*, Aluminum Company of America; *Donald A. MacRae*, Warner and Swasey Observatory, Case Institute of Technology; *G. H. McIntyre*, Ferro Enamel Company; *William Milliken*, Cleveland Art Museum; *Fletcher A. Reynolds*, Cleveland Zoological Park; *Granville B. Ryan*, Standard Oil Company of Ohio; *Paul E. Sprague*, The Glidden Company; *Ruth Swinart*, Thompson Products Auto Album and Aviation Museum; *Harlan L. Trumbull*, B. F. Goodrich Company; *Emilia E. Wefel*, Cleveland Public Library.

The Association is also indebted to the following who have contributed advice and assistance: *Harold T. Clark*, president, Cleveland Museum of Art; *Frederick C. Crawford*, president Thompson Products, Inc.; *Mervin B. France*, president, Society for Savings; *M. D. Harbaugh*, vice president and secretary, Lake Superior Iron Ore Association; *Elmer L. Lindseth*, president, Cleveland Electric Illuminating Company; *Mark C. Schinnerer*, superintendent, Cleveland Board of Education.

HOUSING AND REGISTRATION

The hotels of Cleveland have pledged themselves to provide ample housing for those attending the 117th Meeting. Housing will be taken care of by the experienced personnel of the Cleveland Convention Bureau, with hotels confirming reservations directly. Announcements and coupons for reservations will appear in *Science* and *The Scientific Monthly*, beginning the last of August. The hotels include the Statler (headquarters of the AAAS), the Hollenden, the Carter, the Allerton, the Olmsted, and the Auditorium Hotel, the last particularly convenient for exhibitors.

At the New York Meeting, the Council of the Association voted overwhelmingly to continue with advance registration. Plans are already made to ensure the mailing of the General Program to advance registrants not later than December 1 (as compared with December 6–9 last year).

RAYMOND L. TAYLOR,
Assistant Administrative Secretary

Scientific Book Register

The Actinomycetes. Annales Cryptogamici et Phytopathologici, Vol. 9. Selman A. Waksman; Frans Verdoorn, Ed. Waltham, Mass.: Chronica Botanica; New York City: Stechert-Hafner, 1950. 230 pp. $5.00.

Problems of Morphogenesis in Ciliates: The Kinetosomes in Development, Reproduction and Evolution. André Lwoff. New York: John Wiley; London: Chapman & Hall, 1950. 103 pp. $2.50.

A History of Experimental Psychology. 2nd ed. Edwin G. Boring. New York: Appleton-Century-Crofts, 1950. 777 pp. $6.00.

Cell Growth and Cell Function: A Cytochemical Study. Torbjoern O. Caspersson. New York: W. W. Norton, 1950. 185 pp. $5.00.

Supersonic Aerodynamics: A Theoretical Introduction. Edward R. C. Miles. New York: McGraw-Hill, 1950. 255 pp. $4.00.

Data and Circuits of Receiver and Amplifier Valves, Book III. Trans. by G. Ducloux. Einhoven, Netherlands: Philips' Technical Library; New York: Elsevier, 1949. 409 pp. $2.75.

Data and Circuits of Modern Receiver and Amplifier Valves, Book III. Trans. by G. Ducloux. Eindhoven, Netherlands: Philips' Technical Library; New York: Elsevier, 1949. 213 pp. $1.90.

Electricity for Students of Science and Engineering. T. Townsend Smith. Scranton, Pa.: International Textbook, 1949. 410 pp. $5.00.

Time and Its Mysteries, Series III. Henry Norris Russell *et al.* New York: New York Univ. Press, 1949. 126 pp. $3.00.

Fundamentals of Physical Chemistry for Premedical Students. H. D. Crockford and Samuel B. Knight. New York: John Wiley; London: Chapman & Hall, 1950. 366 pp. $4.25.

One Family: Vitamins, Enzymes, Hormones. Benjamin Harrow. Minneapolis, Minn.: Burgess Publ., 1950. 115 pp. $2.00.

NEWS and Notes

Elvin C. Stakman, chief of the Division of Plant Pathology and Botany, University of Minnesota, and retiring president of the AAAS, is in Florence, Italy, attending the Fifth General Conference of Unesco, May 22–June 16. Dr. Stakman is a member of the U. S. delegation.

S. E. Luria, of the Department of Bacteriology, University of Indiana, will give a special course on viruses this month in the Department of Biophysics at the University of Colorado Medical Center in Denver. The course will include lecture and laboratory sessions. Further information about the registration may be obtained by writing to the department, 4200 E. Ninth Avenue, Denver.

Herbert R. Morgan, professor of medicine at the University of Michigan Medical School, has been appointed professor of bacteriology and chairman of the Department of Bacteriology and Preventive Medicine in the University of Rochester's School of Medicine and Dentistry.

Major General Sir Sahib Singh Sokhey, former director of the Haffkine Institute of Bombay, has been appointed assistant director general of the World Health Organization, in charge of the Central Technical Services. He replaces Raymond Gautier, who recently retired.

John Deal, has been appointed entomologist for the World Health Organization, to organize and put into operation an insect control program in the six Central American countries, including British Honduras.

Glenn A. Noble, head of the Department of Biology at California State Polytechnic College, has accepted an appointment under the Smith-Mundt Act as visiting professor of parasitology at Seoul National University, Seoul, Korea.

Harvey Brooks has been appointed Gordon McKay Professor of Applied Physics at Harvard University, effective July 1. Dr. Brooks is now on the staff of the Knolls Atomic Power Laboratory of the General Electric Company in Schenectady.

Visitors to U. S.

Three staff members of the Instituto Technico de la Construccion y del Cemento, Madrid—**E. Torroja,** director, **J. Nadal,** first secretary, and **Francisco Lucini,** institute architect, recently visited the National Bureau of Standards as part of their study of construction and cement industries and research laboratories in the U. S. **Sakuji Komagata,** director of the Electrotechnical Laboratory, Tokyo, visited the electrical and optical laboratories of the bureau.

Youssef Abdoosh, director of the Royal Medical Corps Laboratories, Egyptian Army, and deputy director of the Egyptian Army Medical Corps, recently visited the Army Medical Department Research and Graduate School, Washington, D. C., to study the layout of a large research laboratory. He was accompanied by **Salah El-Dine Rifaat,** chief of the Civil Engineering Branch of the Military Works Department. **C. E. van Rooyen,** professor of virus infections at the University of Toronto, visited the Department of Virus and Rickettsial Diseases; and **John I. L. Browne,** director of the university clinic of Royal Victorial Hospital, and professor of medicine, McGill University, also visited the school during May.

John Krog, biologist from the Teachers' College, Oslo, Norway, and his wife, who is a botanist, have joined the staff of the U. S. Public Health Service field station at Anchorage, Alaska. Mr. and Mrs. Krog, who are in the U. S. under the exchange visitors program of the State Department, will assist Laurence Irving, director of the Study Unit in Physiology and Experimental Biology, in investigations of metabolic changes in arctic and subarctic birds and mammals.

N. S. Bayliss, of the University of Western Australia, was a recent visitor at the Iowa State College Institute for Atomic Research.

P. S. Gill, chairman of the Department of Physics and dean of the Faculty of Sciences of Aligarh University, India, will be at the Bartol Research Foundation of the Franklin Institute, Swarthmore, Pennsylvania, until July 1.

Beno Eckmann, of the Zurich Federal Institute of Technology, and **H. D. Kloosterman,** of the University of Leiden, will be visiting professors in the Department of Mathematics at the University of Michigan during the summer term.

The annual McGregory Lecture on Chemistry of Colgate University was given May 23 by **N. V. Sidgwick** of Oxford University. The subject of the lecture was the scope of inorganic chemistry.

Grants and Awards

The Eli Lilly and Company Award in Bacteriology was given last month to Roger Yate Stanier, associate professor of bacteriology at the University of California at Berkeley. Dr. Stanier was cited particularly for his work in helping to classify bacteria in the family mycobacteriaceae. The $1,000 award is conferred annually by the Society of American Bacteriologists to a scientist under 35 years of age.

Research Corporation announced May 1 the award of 26 new grants in aid of research and renewal of nine grants on projects already supported by the foundation to colleges, universities, and scientific institutions in 21 states. The $80,000 allocation, which includes Research Corporation general grants and Frederick Gardner Cottrell grants to smaller institutions, bring to a total of about $350,000 the funds granted since November 1, 1949, when the last awards were made.

The new awards are as follows: Pomona College—*R. Nelson Smith,* the reaction of nitric oxide with methyl radicals; University of California at Davis—*Raymond M. Keefer* and *Lawrence J. Andrews,* addition and substitution reactions of halogens on the aromatic nucleus; University of California—*Lawrence M. Grossman,* measurements of turbulent velocity components in axisymmetric liquid flow; John B. Stetson University—*Leonard G. Tompkins,* studies in the preparation of ali-

phatic nitroketones; Georgia Institute of Technology—*Jack Hine*, the reactivity of methylene halides in nucleophilic displacement reactions; North Georgia College—*Paul Becher*, a study of the chemical behavior of trimethyl phosphate mono- and dimethyl phosphoric acid with respect to reactivity; Lake Forest College—*Harold C. Jensen*, cathode ray bombardment of semiconductors; Wheaton College—*Bernard A. Nelson*, a further study in the reactions of alphahalogenated ethers; Yerkes Observatory of the University of Chicago—*Karl O. Kiepenheuer*, determination of the magnetic field of the sun; University of Kansas—*William E. McEwen*, the mechanism of the acid-catalyzed conversion of furfuryl alcohol to levulinic acid; Lowell Textile Institute — *Geoffrey Broughton*, bonding character in the paper sheet; Mississippi State College—*Henry C. Thomas*, Auger electrons in coincidence experiments; University of Missouri—*Newell S. Gingrich*, the development of equipment for the experimental study of low intensity effects in the diffraction of x-rays; Montana State College—*Kenneth J. Goering*, a study of purified amylase from various fungi grown in submerged culture; University of Nebraska—*Carl W. Borgmann*, influence of environmental factors on the cathodic polarization of common metals and alloys; Syracuse University—*Gerald F. Grillot*, synthesis of substituted phenothiazines; University of North Dakota—*Grant W. Smith*, influence of applied potential difference across a liquid-liquid interface; Denison University—*Conrad E. Ronneberg*, a study of trifluoracetic acid as an electrolyte; Wittenberg College — *Paul K. Glasoe*, a study of the correlation between spectrophotometric characteristics of colloidal gold and the particle size, concentration of gold in the sol, and method of preparation of the sol; University of Oregon—*V. R. Gaertner*, synthesis of strained fused polynuclear hydrocarbons; Haverford College — *Thomas O. Jones*, the preparation and characterization of the various tolylhydrazides both from esters and from acids; Pennsylvania State College—*Hans Neuberger*, a study of atmospheric condensation; University of Pennsylvania — *David M. Howell*, studies on hydroxylamines and their metal complexes; Fisk University—*Nelson Fuson*, a study of the mercapturic acid synthesis of the animal body by means of infrared spectroscopy; University of Tennessee — *William H. Fletcher*, vibrational assignments and force constants of ketene, allene, and related molecules; and West Virginia University — *Saul W. Chaikin*, the chemistry of organoboronic acids and their derivatives.

Fellowships, Scholarships,

The National Foundation for Infantile Paralysis has approved an additional $150,000 for continuation of the Physical Therapy Scholarship Program. More than $1,950,000 has been allocated since 1942 for such training, and more than 1,300 physical therapists have received complete or partial training. In addition, 27 fellowships for preparation as physical therapy teachers have been made. The program will continue to be administered by the foundation, with a committee from the American Physical Therapy Association. Requests for information or applications should be directed to Professional Education Division, National Foundation for Infantile Paralysis, 120 Broadway, New York City.

A Hoblitzelle National Award in Agricultural Sciences has been established by the Karl Hoblitzelle Agricultural Laboratory of the Texas Research Foundation to give recognition to outstanding contributions to agriculture and the sciences that serve agriculture, including bacteriology, biochemistry, biology, botany, chemistry, entomology, forestry, genetics, nutrition, soil science, veterinary science, and zoology. The $5,000 award and gold medal will be presented biennially to the person who has made the most important scientific contribution to American agriculture for the preceding two-year period. The first award will be made in 1951. Nominations will be made by duly appointed committees and equal consideration will be given to all scientists working in the U. S. and territories. Two other awards of $5,000 each are to be made for work done by Texans, for the advancement of agriculture within the state.

Colleges and Universities

The Rutgers University Serological Museum recently received samples of blood serum from 20 animals native to Heard Island in the Indian Ocean near the South Pole. The specimens, including blood fluids from penguins, seals, sea lions, leopards, sea elephants, and several birds of the petrel family, including one albatross, were brought to the museum by Ellen Clark, of Mooroolbark, Victoria, Australia, who will spend a year's study at the museum on a grant from the Rockefeller Foundation. Miss Clark has been research assistant of the Council for Scientific and Industrial Research in Australia since 1945.

The University of Rochester recently opened a new million-dollar center for research and training of physicians and technicians in medical problems relative to atomic energy development. The center, financed by the Atomic Energy Commission, is planned to help provide medical training to the armed forces for atomic warfare defense, to acquaint civilians with various aspects of atomic energy, and to supply a source of trained research scientists for the regional laboratories of the AEC. Henry A. Blair, physiologist and biophysicist, is director of the project, which was begun under the Manhattan District during the war.

Summer Programs

A summer seminar in statistics is scheduled for the period August 7–September 2, under the auspices of the University of Connecticut at Storrs. Informal discussions and colloquia on a wide range of statistical topics will be held. Institutions represented on the seminar's executive committee are Columbia, Cornell, Harvard, Johns Hopkins, Yale, Princeton, University of Connecticut, University of North Carolina, and Connecticut Agricultural Experiment Station. Attendance for the entire four-week period is not

required. Those interested should write to the seminar's executive secretary, D. F. Votaw, Jr., 210 Leet Oliver Hall, Yale University, New Haven, Connecticut.

The Wyoming Geological Association will hold its fifth annual field conference August 9–11 in southwest Wyoming. The conference will have headquarters in Kemmerer, Wyoming, but daily field trips ranging from the Uinta Mountain on the south to the Wind River on the north will allow the group to study the geology of a wide area of the Green River Basin and the Western Wyoming overthrust belt.

A one-week course on the **medical aspects of nuclear energy** is scheduled by the Army Medical Department Research and Graduate School for September 18–22. Further information can be obtained from the U. S. Army Surgeon General's Office, Education and Training Division, Main Navy Building, Washington, D. C.

Meetings and Elections

A symposium on thin films, sponsored by the Armour Research Foundation of the Illinois Institute of Technology, will be held at the Sheraton Hotel, Chicago, June 8–10. The symposium will be divided into four sessions covering formation, geometry, structure, and the problems and applications of thin films. Each session will have as chairman an authority in the field who, with a group of experts, will present a discussion on that phase of thin film study. Chairmen of the sessions are K. B. Blodgett, General Electric Company; L. O. Brockway, University of Michigan; A. T. Gwathmey, University of Virginia; and R. D. Heidenreich, Bell Telephone Laboratories. On Friday and Saturday those attending may present their thin film problems to the symposium for attention and recommendations.

Exhibitors at this year's instrument display will include the American Optical Company, Distillation Products, North American Philips, Optical Film Engineering, and Radio Corporation of America.

The Pacific Division of the AAAS will hold its 31st annual meeting at the University of Utah, Salt Lake City, June 19–24. Headquarters will be located in the lobby of the Union Building on the university campus. Meetings of participating organizations will be held on the following dates: *American Chemical Society, Northwestern Utah Section*—June 20–22; *American Meteorological Society*—June 20–22; *American Nature Study Society, Western Section*—June 21–24; *American Phytopathological Society, Pacific Division*—June 21–23; *American Society for Horticultural Science, Western Section*—June 20–23; *Botanical Society of America, Pacific Division*—June 22–23; *American Society of Ichthyologists and Herpetologists (national meeting)*—June 20–22; *American Society of Limnology and Oceanography, Pacific Section*—June 21–22; *Cooper Ornithological Club, Northern Division*—June 22–23; *Association of Pacific Coast Geographers*—June 22–24; *Astronomical Society of the Pacific*—June 22–23; *Pacific Northwest Bird and Mammal Society*—June 22–23; *Society of American Bacteriologists, Southern California Branch and Intermountain Branch*—June 22; *Herpetologists League*—June 20–22; *Society for Experimental Biology and Medicine, Pacific Coast Branch and Southern California Branch*—June 20; *Ecological Society of America, Western Section*—June 20–22; *American Society of Plant Physiologists, Western Section*—June 21–23; *Western Society of Soil Science*—June 20–22; and the *Utah Academy of Sciences, Arts, and Letters*—June 21.

The Western Association of Industrial Physicians and Surgeons invites all American Medical Association members to attend its meeting on Sunday, June 25 (the day prior to the opening of the AMA convention), from 9:00 to 5:00, in the Curran Theater, 455 Geary Street, San Francisco.

The Third International Institute for Hospital Administrators will be held in Rio de Janeiro June 18–July 2. Thirty-two governmental and scientific institutions in the U. S. and Latin American republics are collaborating in the work of the institute.

The American Congress of Physical Medicine will hold its 28th annual meeting at the Hotel Statler, Boston, August 28–September 1. All sessions will be open to members of the medical profession in good standing with the AMA. In addition to scientific sessions, annual instruction seminars will be held on the first four days. One set of 10 lectures on basic subjects will be limited to physicians. Another set of 10 general lectures will be open to therapists as well as physicians. Full information may be obtained from the American Congress of Physical Medicine, 30 North Michigan Avenue, Chicago.

The American Geophysical Union (Committee on Geophysics of the National Research Council) elected the following officers to serve from July 1, 1950 to June 30, 1953: president, Walter H. Bucher, Columbia University; vice president, F. W. Reichelderfer, U. S. Weather Bureau; and general secretary, K. Hilding Beij, National Bureau of Standards.

The Genetics Society of America will meet at Columbus, Ohio, September 11–14, under the auspices of the American Institute of Biological Sciences, to celebrate the 50th birthday of the rediscovery of Mendel's fundamental work. Short papers describing the results of current research will be presented the first day of the meeting. On Monday evening, an address on "The Impact of Genetics on the Biological Sciences" will be given by R. B. Goldschmidt, professor emeritus of zoology at the University of California. On September 12, papers will be presented on the historical aspects and the development of genetics; on September 13, the general topic will be the physical basis of the gene and the physiology of the gene. Three papers on cytogenetics are scheduled for Thursday morning, to be followed by several dealing with genetics,

and food supply, and genetics, medicine, and man. The final address will be delivered Thursday evening by Julian Huxley, entitled "Genetics, Evolution, and General Thought."

An international congress of electronic microscopy will be held in Paris, France, September 14–22, under the sponsorship of the French Society of Theoretical and Applied Microscopy. The five sections of the congress will include electronic optics and microscopes, electronic diffraction, and metallurgic, chemical, and biological applications. U. S. scientists who have been named to serve on the Honorary Committee include F. O. Schmitt, professor of biology, Massachusetts Institute of Technology; R. W. S. Wyckoff, chief of the Section on Molecular Biophysics, National Institutes of Health; and L. Marton, chief of the Electron Physics Section, National Bureau of Standards. Those chosen for the General Committee are R. C. Williams, associate professor of physics, University of Michigan, and S. G. Ellis, research physicist, RCA Laboratories, Princeton, New Jersey. Committee lists are not yet complete. Those wishing to attend the congress should write immediately to the Secrétariat, Laboratoire de Cryptogamie du Museum National d'Histoire Naturelle, 12, rue de Buffon, Paris, France.

The New Orleans Academy of Sciences, on April 28, elected the following officers for 1950–51: president, Henry Bull, Southern Forest Experimental Station; vice president, Mary Rollins, Southern Regional Research Laboratory; secretary, Walter G. Moore, Department of Biology, Loyola University; and treasurer, Karlem Riess, Department of Physics, Tulane University.

The Iowa Academy of Science elected the following officers at its meeting last month: president, P. S. Helmick, Drake University; vice president, F. E. Brown, Iowa State College; editor, F. G. Brooks, Cornell College; and secretary-treasurer, Cornelius Gouwens, Iowa State College.

Deaths

Leland O. Howard, authority on insect pests, died May 1 at his home in Bronxville, New York, at the age of 92. Dr. Howard was head of the Department of Agriculture's Bureau of Entomology from 1894 to 1927, when he relinquished the directorship but remained as chief entomologist until he retired in 1931.

Ruric C. Mason, head of the Physics Department, Westinghouse Electric Corporation, died May 12 at his home in Pittsburgh. He was 47 years old. Dr. Mason was one of a group of scientists sent to Oak Ridge, Tennessee, in 1946 to study problems of atomic power plant development.

Leonas L. Burlingame, professor emeritus of biology at Stanford University, died at his home in Palo Alto, California, on April 8 at the age of 74. Dr. Burlingame's principal interests were plant morphology, the genetics of *Lupinus* and *Clarkia*, cytogenetics, and the genetics of human population. He was a former president of the Society of Sigma Xi.

Plane space to Europe is available on August 1 to scientists wishing to attend meetings abroad. The plane was chartered by the American Physiological Society to serve physiologists attending the 18th International Physiological Congress in Copenhagen August 15–18 and several places are still unfilled which must be taken if the charter is not to be canceled. Scientists attending scientific meetings in Europe are eligible, together with members of their families. The plane is a 44-passenger Pan American Constellation in regular transatlantic service. It will leave at 1:00 p.m., August 1, from Idlewild, Long Island, New York, and arrive in London August 2. Return may be made on any regularly scheduled plane. The round trip fare is $500. Those interested should communicate at once with The Clara Laughlin Travel Services, Inc., 38 East 57th Street, New York City. Telephone, Plaza 9-7892.

An invitation to all artistically inclined chemists to submit their work for display at the National Chemical Exposition, to be held September 5–9 at the Chicago Coliseum, has been issued by Seymour Goldfarb, art exhibit chairman. The idea for the art exhibit originated with Harry N. Holmes, professor emeritus of chemistry at Oberlin College, a former president of the ACS, and an amateur painter. Members of the ACS and student affiliates may submit as many as three entries each. Chemists outside the continental U. S. may show two entries. Photographs and sculpture will not be accepted but any type of painting—oils, tempera, water color, etchings, and prints will be shown. Awards will be made in the various classes by a jury to be appointed. Exhibitors must pay their own transportation and insurance charges in transit, but the exposition will insure, unpack, hang, and repack all work submitted and return it without cost to the exhibitors. Inquiries should be addressed to Mr. Goldfarb at 86 East Randolph Street, Chicago 1.

Make Plans for—

Symposium on Theory of Electromagnetic Wave Propagation, June 6–8, New York University, New York City.

Stillwater Conference, cosponsored by the Foundation for Integrated Education and Oklahoma A & M College, June 6–9, Stillwater, Oklahoma.

Symposium on Nuclear Physics and Light Elements, June 8–9, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

American Electroencephalographic Society, 3rd annual meeting, June 9–11, **American Society of Neuropathologists,** June 11, **American Neurological Association,** annual meeting, June 12–14, Claridge Hotel, Atlantic City, New Jersey.

American Society of Medical Technologists, annual convention, June 11–15, Shamrock Hotel, Houston, Texas.

Symposium on Molecular Structure and Spectroscopy, June 12–17, Mendenhall Laboratory of Physics, Ohio State University.

WILEY

New Books of Interest

MID-CENTURY

The Social Implications of Scientific Progress. Edited by JOHN BURCHARD, *The Massachusetts Institute of Technology.* Contains the complete program of M.I.T.'s 1949 convocation on the inauguration of President James R. Killian, Jr. Statesmen, scientists, philosophers, educators, and businessmen contributed their thoughts on major issues of the day. Among the participants were Churchill, Stassen, and Senator Flanders; Karl Compton, Vannevar Bush, and Sir Henry Tizard; Jacques Maritain and Percy Bridgman; and many others of like stature. None of the major issues discussed is exclusively technological but all are influenced or created by an advancing technology and are of immediate concern to the modern world. A TECHNOLOGY PRESS PUBLICATION. *Ready in June. Approx. 770 pages. Prob. $5.00.*

SOME THEORY of SAMPLING

By W. EDWARDS DEMING, *Bureau of the Budget and New York University.* Presents the theoretical background plus the practical applications of modern statistical practice. Parts I, II, and III cover the problems which arise in planning surveys. Part IV gives a step-by-step summary of how the theory of sampling was applied to two real problems. Part V goes into advanced theory that can be used in the design and analysis of samples. One of the WILEY PUBLICATIONS IN STATISTICS, Walter A. Shewhart, Editor. *Ready in June. 602 pages. $9.00.*

METHODS of STATISTICAL ANALYSIS

By A. HALD, *University of Copenhagen.* Emphasis is placed on methods useful in engineering. This present edition in English contains new material on quality control not included in the original Danish edition. *In press. Volume I: Text—Approx. 654 pages; Prob. $7.50. Volume II: Tables—Approx. 80 pages; Prob. $1.50.*

INDUSTRIAL CHEMICALS

By W. L. FAITH, *Corn Products Refining Company,* DONALD B. KEYES, *Heyden Chemical Corporation,* and RONALD L. CLARK, *Mellon Institute of Industrial Research.* The first one-volume compilation of important technical and economic data concerning more than 100 major industrial chemicals. The selection has been limited to chemicals made at least in part by synthetic or biochemical methods. *Ready in August. Approx. 644 pages. Prob. $8.00.*

Send for copies on approval.

JOHN WILEY & SONS, Inc.

440 Fourth Avenue New York 16, N. Y.

fifth annual

AAAS — GEORGE WESTINGHOUSE

$1000 AWARDS

for Newspaper and Magazine Science Writing

ELIGIBILITY

Only entries appearing in newspapers and magazines published within the continental limits of the United States are eligible. Persons other than the author may nominate entries in accordance with the rules. Articles from AAAS publications are not eligible, and previous winners of the awards are automatically disqualified.

CONDITIONS

NEWSPAPERS—($1000 AWARD)—Each entrant must submit three (and only three) separate published articles written during the contest year, one of which must be designated as the entry upon which he wishes to be judged. Completed entry blank must accompany each exhibit, with three copies of each story in the form of tear sheets, photostats, clippings, reprints, or syndicate copy, showing name and date of the publication. To receive the Award, the winner must be present at the Annual Meeting of the American Association for the Advancement of Science in Cleveland, Ohio, December 28, 1950. His expenses will be paid.

MAGAZINES—($1000 AWARD)—Each entrant must submit one published article written during the contest year, but may submit up to three. A completed entry blank must accompany each exhibit, with three copies of each story in the form of tear sheets, photostats, clippings, reprints, or syndicate copy, showing name and date of the publication. To receive the Award, the winner must be present at the Annual Meeting of the American Association for the Advancement of Science in Cleveland, Ohio, December 28, 1950. His expenses will be paid.

CRITERIA

Entries will be judged on initiative, originality, scientific accuracy, clarity of interpretation, and the story's value in promoting a better understanding of science by the public. The decision of the Judging Committee will be final.

DEADLINES

The contest year runs from October 1, 1949, through September 30, 1950, and all entries must be postmarked on or before midnight, October 8. The publication date on the issue in which the article appeared will be considered as the date upon which it was in circulation. Winners will be notified on or before December 15, 1950.

INFORMATION

Rules and entry blanks may be obtained by writing to the Chairman, Managing Committee, AAAS-George Westinghouse Science Writing Awards, 1515 Massachusetts Avenue, N.W., Washington 5, D. C.

The George Westinghouse Science Writing Awards, administered by the American Association for the Advancement of Science, are made possible by a grant from the Westinghouse Educational Foundation. By the terms of the grant the Association is instructed to recognize superior journalistic writing, with particular emphasis on the interpretation of scientific research and progress to the general public. Separate $1,000 Awards are made for newspaper and for magazine science writing.

Outstanding texts in the biological sciences

Manual for Comparative Anatomy

Revised Edition

By Leonard P. Sayles

This manual features a unique arrangement, listing parts in one column, each followed by the descriptive material. Either type study or comparative study of systems is facilitated by this method. The revision includes 37 new illustrations, bringing the total to 92. All illustrations are fully and directly labelled. *To be published in August.*

Biology of the Vertebrates

Third Edition

By Walter and Sayles

In making the revision, Dr. Sayles has kept the flavor of the previous editions while bringing all the information up to date. Many new illustrations have been selected from a variety of sources, and several chapters have been rewritten in the light of recent research. $6.00

Fundamentals Of Comparative Embryology Of The Vertebrates

Revised Edition

By Alfred F. Huettner

Maintaining the same general plan of organization and morphological point of view, the revised edition of this popular text has been brought completely up to date. Two completely new chapters have been added; one on the history and theories of development, and the other on the embryology of the mammal. The original drawings by the author are unsurpassed in biological textbooks. $5.00

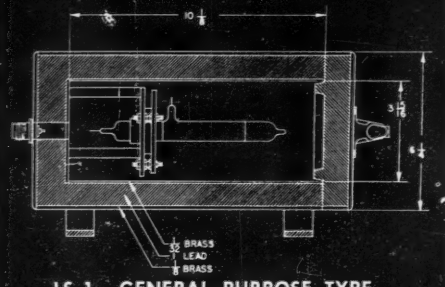
College Botany

By Hylander and Stanley

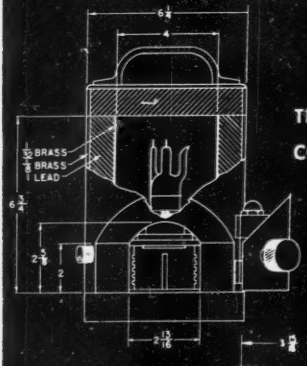
This new text is designed for a full-year course in general botany. Part I discusses the individual plant and its life problems, using a woody green plant to introduce the student to the basic facts of plant morphology, histology, and cell structure and function; Part II deals with plants as groups in our large vegetation complex. $5.00

THE MACMILLAN COMPANY, 60 Fifth Avenue, New York 11

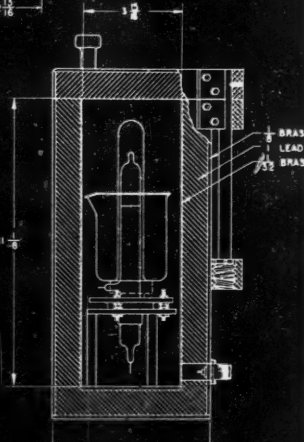
LEAD SHIELDS
For Geiger Counters



LS-1 GENERAL PURPOSE TYPE



LS-2
THIN-WINDOW
COUNTER TYPE

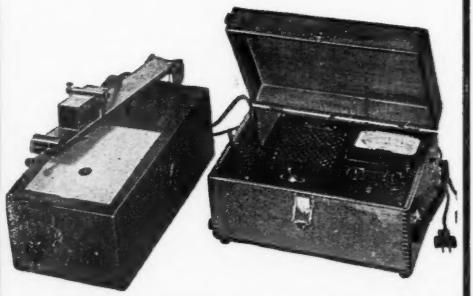


LS-4
LIQUID
SAMPLE
TYPE

WRITE FOR DETAILS ON COMPLETE LINE OF LEAD SHIELDS

TECHNICAL ASSOCIATES
PIONEER MANUFACTURERS OF RADIATION INSTRUMENTS
3728 SAN FERNANDO ROAD, GLENDALE 4, CALIFORNIA

PHOTOVOLT
Electronic
Transmission Densitometer



- For accurate measurements of transmission density of photographic, photomicrographic, x-ray, spectrographic, and x-ray diffraction plates and films.
- For radiation monitoring with x-ray films.
- For exposure determination in photomicrography by direct light measurements in the focal plane.

Write for Bulletin #250 to

PHOTOVOLT CORPORATION
95 Madison Ave. New York 16, N. Y.

Also: Colorimeters, Fluorescence Meters, pH Meters, Photometers

another
SCIENCE
ADVERTISER
expresses his satisfaction

". . . . we feel that our advertisements in SCIENCE have been of great value to us in making our animals known throughout the scientific world. . . . We consider it one of the best mediums for this purpose."
Name on Request

YOU will also be satisfied at the results SCIENCE produces for you, because . . . the more than 33,000 scientists who subscribe to SCIENCE are an influencing factor in determining just what equipment and supplies will be purchased for the educational institutions, research foundations and industrial laboratories in the United States and 76 foreign countries.

Your advertisement in these columns reaches a distinguished, an influential, and a *responsive* audience —at reasonable cost.

- *Write for Rate Card 26C Today . . . let SCIENCE PRODUCE FOR YOU.*

Introducing:

ANNUAL REVIEW OF PLANT PHYSIOLOGY

Volume 1

This book will be off the press in July, 1950. It is the first volume in a new series of Annual Reviews, consisting of approximately 370 pages, including author and subject indexes.

Editor: D. I. Arnon; Associate Editor: Leonard Machlis

Editorial Committee: D. R. Goddard, P. J. Kramer, A. E. Murneek, M. W. Parker, and K. V. Thimann

Contents: Mineral Nutrition of Plants, E. G. Mulder; Nitrogen Metabolism of Higher Plants, F. C. Steward; Soil Chemistry in Relation to Inorganic Nutrition of Plants, P. R. Stout, and R. Overstreet; Carbon Dioxide Fixation by Green Plants, M. Calvin and A. A. Benson; Influence of Light on Plant Growth, M. W. Parker and H. A. Borthwick; Plant Tropisms, A. R. Schrank; Transformation of Carbohydrates in Plants, W. Z. Hassid and E. W. Putman; Respiration in Higher Plants, D. R. Goddard and B. J. Meeuse; Organic Acid Metabolism, K. V. Thimann and W. D. Bonner; Plant Growth Substances in Relation to Horticulture, J. W. Mitchell and P. C. Marth; Herbicides, A. G. Norman; Water Relations of Plant Cells and Tissues, P. J. Kramer and H. B. Currier; Plant Growth in Relation to Soil Moisture, F. J. Viehmeyer and A. H. Hendrickson; Postharvest Physiology and Biochemistry of Fruits, J. B. Biale; Physiological Aspects of Cell Wall, A. Frey-Wyssling;

Volume 19

ANNUAL REVIEW OF BIOCHEMISTRY

This book will be off the press in August, 1950. 590 pages, including author and subject indexes.

Editor: J. M. Luck; Associate Editors: G. Mackinney and H. A. Loring

Editorial Committee: H. J. Almquist, A. K. Balls, H. J. Deuel, Jr., J. M. Luck, and H. A. Spoehr

Contents: Biological Oxidations, V. R. Potter; Proteolytic Enzymes, M. Lastowski; Nonproteolytic Enzymes, P. O. Cohen and R. W. McGilvery; Chemistry of the Carbohydrates, M. L. Wolfrom; Chemistry of the Lipids, H. J. Deuel, Jr.; Chemistry and Metabolism of the Steroids, G. Pincus; Chemistry of Amino Acids and Proteins, K. Cannan and M. Levy; Nucleic Acids, Purines, and Pyrimidines, G. Schmidt; Carbohydrate Metabolism, S. Ratner and E. Racker; Lipid Metabolism, G. Medes; Metabolism of Proteins and Amino Acids, P. P. Swanson; Chemistry of the Hormones, A. White; Water-Soluble Vitamins, E. E. Snell; Fat-Soluble Vitamins, T. Moore; Nutrition, H. M. Sinclair; Muscle, F. B. Straub; Chemistry of Neoplastic Tissues, C. Carruthers; Chemical Composition of Blood Plasma and Serum; H. A. Krebs; Pyrrole Pigments, R. Lemberg and J. W. Legge; Immunochemistry, P. Grabar; Biochemistry of Antibiotics, H. E. Carter; Partitian Chromatography, A. J. P. Martin.

"The general style, and the persistently high standard, of the Annual Review may be assumed to be well known to every reader of this journal . . .". Arch. Biochem., 24, No. 2, Dec., 1949.

". . . The scope and nature of the publication render it an asset to all biochemical research libraries." Bull. Imperial Inst., 46, No. 2, 1948.

"This volume, like the preceding ones, should be of great interest and importance to all those who are concerned with research in plant and animal chemistry. . . ." Soil Science, 69: 1, Jan. 1950.

Volume 3

ANNUAL REVIEW OF MICROBIOLOGY

Published in November, 1949. 476 pages, including author and subject indexes.

Editor: C. E. Clifton; Associate Editors: S. Raffel and H. A. Barker

Editorial Committee: M. D. Eaton, W. E. Herrell, J. M. Sherman, E. C. Stakman, W. H. Taliaferro, and C. B. van Niel

Contents: Bacterial Variation, J. Lederberg; Morphology, Cytology, and Taxonomy of the Actinomycetes, D. Erikson; Ciliated Protozoa; Cytogenetics, Genetics, and Evolution, T. M. Sonneborn; Metabolism of Microorganisms, W. W. Umbreit; Nutrition of Microorganisms, E. E. Snell; Constituents of Viruses, C. A. Knight; Actions of Antibiotics in Vivo, W. C. Cutting; The Cellular Basis of Immunity, W. H. Taliaferro; Virulence and Pathogenicity, D. W. Watson and C. A. Brandly; Types of Acquired Immunity Against Infectious Disease, S. Raffel; Chemistry of Toxins, L. Pillemer and K. C. Robbins; Nature and Variability of Disease Resistance in Plants, H. Hart; Oral Microbiology, R. W. Harrison; Dermatropic Viruses, G. J. Buddingh; Food Microbiology, H. O. Halvorson; The Growth of Bacterial Cultures, J. Monod; Recent Developments in Microbiological Techniques, L. S. McClung; Bacteriophage, J. Fong.

". . . These reviews are of great value to microbiologists, but they are of even more importance to workers in other fields of biology who are less familiar with recent developments in microbiology, but need to be kept informed concerning them. . . ." Soil Science, 69: 2, Feb. 1950.

". . . After perusal of this volume, one comes to the conclusion that Annual Review of Microbiology is an authoritative publication. It covers a rapidly growing science that borders on many fields." The Chemist, 26: 4, April, 1949.

Each volume: $6.00

Shipping charges: U.S.A. and Pan American—15 cents; Elsewhere—35 cents

---

ON SALE BY: **ANNUAL REVIEWS, INC.,** Stanford, California, U.S.A.

BACK IN PRINT

•

In response to popular demand, we have again made available this invaluable work:

Atomic Structure of Minerals

By W. L. Bragg **Langworthy Professor of Physics, The Victoria University of Manchester**

"Comprises a thorough survey of the entire field of the internal geometry of crystals and will prove of inestimable value to all concerned with the classification of minerals, as well as those who seek to discover the basic principles of crystallography."—*Scientific Book Club Review*

"The investigation of atomic structure by means of x-rays has now gone far enough to give us data concerning the structure of nearly all the important chemical groups of minerals and will enable us to make a reclassification of mineral species on a more fundamental basis. This book, therefore, is a most important one for every mineralogist."—*American Journal of Science*

305 pages, frontispiece. $3.75

A WIDELY-USED TEXT

The Nature of the Chemical Bond

and the Structure of Molecules and Crystals: An Introduction to Modern Structural Chemistry

By Linus Pauling **Professor of Chemistry, California Institute of Technology**

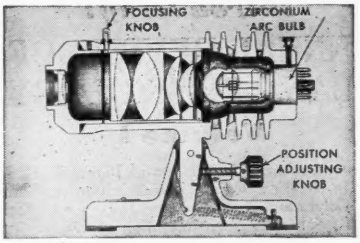
"Marks a most significant modern advance in the field of molecular structure. . . . No book on the subject presents a clearer, more unified panorama of the field."
—Sidney J. French, *Journal of Chemical Education*

"A clearly written survey of the nature of chemical binding as seen from the view-point of the atomic orbital methods."—Robert S. Mulliken, *The Journal of Physical Chemistry*

466 pages, 89 figures, 57 tables, 2nd edition, $4.50

CORNELL UNIVERSITY PRESS
124 Roberts Place, Ithaca, New York

New
Radically different!



"ZIRCONARC" PHOTOMICROGRAPHIC LAMP

For better black-and-white and color photomicrographs

Combines the concentrated light of the Western Union arc light bulb (about 1 mm dia.) with our fluorite-coated, 7-element aplanatic optical system of highest correction, free from chromatic aberration. . . . Practically harmless to living cultures. . . . Built with the same precision as the microscope itself. Over-all length of lamp, 10 ". Height, 6½". Base, 4¼" x 6½". Price, complete with power unit and 40-watt bulb, $325. Order direct or from leading supply dealers.

Write for Bulletin ZL-321S

FISH–SCHURMAN CORPORATION
230 East 45th Street, New York 17, N. Y.

Fish-Schurman

HOT ALCOHOL EXTRACTED
VITAMIN TEST CASEIN

"Vitamin Free" for Biological Tests

Fat and water soluble vitamins are removed by several thorough extractions with hot alcohol. This process, which requires five days of special treatment, provides a product of exceptional purity and uniformity making it ideally suited for use in a wide range of experimental diets. It has been the Vitamin Test Casein of choice of many laboratories for the past ten years.

For other GBI diet materials and supplements write for Booklet No. 677

GENERAL BIOCHEMICALS, INC.

60 LABORATORY PARK — **CHAGRIN FALLS, OHIO**

Reg. U. S. **GBI** Pat. Off.

KLETT ELECTROPHORESIS

CUSTOM MADE

TOOL FOR THE ANALYSIS
OF COMPLEX COLLOID SYSTEMS, AND FOR
THE CONTROL OF PRODUCTION OF
PURIFIED PROTEINS, ENZYMES, HORMONES

KLETT MANUFACTURING CO.
179 EAST 87th STREET
NEW YORK, N. Y.

the Berkeley
MICROTOME KNIFE SHARPENER
assures an
INCOMPARABLE EDGE
3 times faster...

COMPARE THE EDGES. Photomicrograph *(a)* shows a microtome knife edge sharpened by the Berkeley sharpener. Note its even smoothness, assurance of better sections. Photomicrograph *(b)* shows a blade laboriously hand sharpened, honed and stropped, but note the nicks and serrations still remaining.

COMPARE THE TIME. In tests, wherever made, and in practice in hundreds of laboratories, the Berkeley Microtome Knife Sharpener gives perfect edges in one-third the time required for hand honing and stropping.

Let us send you Bulletin MKS-12 giving full information about this indispensable laboratory aid.

Berkeley Scientific Company
SIXTH AND NEVIN AVE • RICHMOND, CALIFORNIA

PRACTICAL TELEVISION ENGINEERING

By Scott Helt

JUST OUT!

Complete, modern data on the practical and theoretical aspects of TV engineering

700 pages, 6 x 9, 385 illus., $7.50

Just off press, comes the first book since the war that covers the entire field of Television from the viewpoint of a practical engineer actually employed in the field. Written by one of the industry's pioneer engineers, PRACTICAL TELEVISION ENGINEERING starts with the fundamentals of picture transmission and progresses logically through every phase of its subject with special emphasis on Television manufacturing and broadcasting.

Subjects include: picture transmission fundamentals; cathode-ray tubes and oscillographs; electron tubes for image pickup; synchronizing generators; shaping and deflection circuits; video amplifiers, cathode follower; power supplies; receivers; camera chains; transmitters; broadcasting techniques; etc.

10-DAY MONEY-BACK GUARANTEE

Dept. S-60, Murray Hill Books, Inc.
232 Madison Avenue, New York 16, New York

☐ Enclosed find $7.50 for Helt's PRACTICAL TELEVISION ENGINEERING: or ☐ send C.O.D. and I will pay postman this amount plus postage. In either event, if book is not satisfactory, I may return it within 10 days and you guarantee to refund the purchase price.

Name .....

Address .....

City, Zone, State .....

Personnel Placement

CHARGES and REQUIREMENTS for "PERSONNEL PLACEMENT" Ads

1. **Rate:** 15¢ per word, minimum charge $3.00 for each insertion. If desired, a "Box Number" will be supplied, so that replies can be directed to SCIENCE for immediate forwarding. Such service counts as 8 words (e.g., a 25-word ad, plus a "Box Number", equals 33 words). All ads will be set in regular, uniform style, without display; the first word, only, in bold face type.

For *display* ads, using type larger or of a different style than the uniform settings, enclosed with separate border rules, the rate is $16.00 per inch; no extra charge for "Box Numbers".

2. **Advance Payment:** All Personnel Placement ads, *classified* or *display*, must be accompanied by correct remittance, made payable to SCIENCE. Insertion can not be made until payment is received.

3. **Closing Date:** Advertisements must be received by SCIENCE, 1515 Mass. Ave., N.W., Washington 5, D. C., together with advance remittance, positively not later than 14 days preceding date of publication (Friday of every week).

POSITIONS WANTED

Biochemist, Ph.D.; two years' teaching experience; six years, research biochemist in industry; considerable administrative experience; interested in research, teaching, chemical administrative positions; for further information, please write Burneice Larson, Medical Bureau, Palmolive Building, Chicago. X

Biologist: retiring shortly; long successful head department in College Liberal Arts would like active academic work. Highest training, wide experience, extensive recognition, unimpaired vigor. Employing institution will not be burdened with aged man—just say good-bye. Box 163, SCIENCE. R6/2

Biophysicist: M.D. Desires position with group developing electronic techniques for medicine and biology. Age 38. 12 years with Navy Medical Corps in internal medicine, aviation medicine, research, teaching and industrial toxicology. Publications. Box 175, SCIENCE. 6/9

Experienced college teacher of science in general education available in September; Ed.M., male, age 34, single. Location unimportant. Candidate for doctorate. Specialty History of Science. Box 178, SCIENCE. X

Geneticist. Woman. Recent Ph.D. Interested in teaching or research, particularly with microorganisms. Box 177, SCIENCE. 6/9

Physical Chemist, Ph.D. Age 28, desires position which requires intelligence and adaptability rather than experience with specific techniques. Experience in reaction kinetics, photochemistry, adsorption. Box 179, SCIENCE. X

Physiologist: M.S. Two years university teaching experience in Mammalian Physiology and Anatomy. Desire teaching or research position in a medical school. Box 176, SCIENCE. X

Physiologist, Biochemist, Ph.D. 18 years research, teaching and administrative experience. Carbohydrate and brain metabolism. Now staff member research foundation. Prefers university post. Box 180, SCIENCE. X

Physiologist, Biophysicist, Ph.D.: Comprehensive experience. Publications; research grants. Seeks position, teaching or research. Box 183, SCIENCE. X

Zoologist with training in physiology, endocrinology, radiobiology, desires teaching or research position. Several years teaching, research experience. AEC post-doctoral fellow. Available September. Box 181, SCIENCE. X

Are YOU seeking a new position?

41 REPLIES received from ONE classified ad in SCIENCE . . . . YOUR ad here will get RESULTS !

(See "Charges and Requirements" above.)

Personnel Placement

POSITIONS OPEN

Magnetic Suspension—Consultation fees available for someone having experience in reducing bearing load of a rotating part by magnetic or electrostatic means. Need not interfere with present occupation. Box 182, SCIENCE. X

Plant Pathologists, 2–4 years experience, college graduate. Starting $295, $358 in California agency. Opportunity for permanent civil service status. Apply before July 25. Recruitment Representative, 1015 L Street, Sacramento, California. X

Positions Open:
(a) Biochemist: Ph.D., to take charge of clinical laboratory, fairly large voluntary hospital; newly created position; opportunity for research, medical school affiliation; $5000–$7000; West. **(b) Chemist** for post of librarian; pharmaceutical company; minimum of Master's degree required; physician eligible; duties consist of scientific writing, abstracting literature; knowledge of French, German desirable. **(c) Assistant director** of laboratories; 300-bed general hospital; administrative ability with background in one of sciences, preferably chemistry, required; $5000–$7000. **(d) Chemist** or chemical engineer with industrial research experience leaning toward inorganic and physical chemistry; challenging opportunity in industry; New England. **(e) Two staff members** for pharmacy department, state university; one should be qualified in pharmacognosy, the other in pharmacy; Middle West. **(f) Associate professor bacteriology;** liberal arts college; $4200–4600; West. S6-1 Burneice Larson, Medical Bureau, Palmolive Building, Chicago. X

Science Editor: General science background in physical and biological sciences with writing and/or publishing experience. Challenging opportunity for younger man in dissemination of scientific knowledge at adult level and publishing. Salary varies with academic training and experience. Address Franklin J. Meine, Editor-in-Chief, American Peoples Encyclopedia, 153 N. Michigan Avenue, Chicago. 6/9

Scientists: Salaried positions, $3,600 to $25,000. This confidential service for outstanding men who desire a change of connection, will develop and conduct preliminary negotiations without risk to present position. Send name and address for details. Tomsett Associates, 1205 Berger Building, Pittsburgh 19, Pa. H

UNIVERSITY OF DACCA, East Bengal, Pakistan.

● Applications are invited for the following posts on terms stated against each:

1. **Professor of Physics**—Salary will depend upon qualifications and may amount to Rs. 2000/- p.m. including allowances. In exceptional cases it may be increased to Rs. 2500/-p.m.
2. **Professor of Botany**—Salary will depend upon qualifications and may amount to Rs. 1500/- p.m. including allowances.
3. **Reader in Geology**—Salary and allowances up to Rs. 1000/-p.m.

(N.B. Re. 1/- = 1/6d)

Appointments will be on deputation or contract not exceeding 5 years or permanent basis in exceptional cases. Benefit of Provident Fund for service not less than five years, contribution to which on either side being 6¼% of the salary. Quarters will be provided on payment of 10% of salary. First class free passage for joining appointment at Dacca will be provided.

Applicants should be distinguished scholars, with experience of teaching and guiding research. Knowledge of English is essential. Candidates should give full details of age, nationality, academic career, teaching experience, and original publications enclosing a copy of each; also testimonials and names and addresses of three referees.

Applications must reach the Registrar, University of Dacca (P.O. Ramna) East Bengal, Pakistan not later than 31st July, 1950.

The Market Place

CHARGES and REQUIREMENTS for "MARKET PLACE" Ads

1. **Rate:** 20¢ per word for *classified* ads, minimum charge $5.00 for each insertion. Such ads are set in uniform style, without display; the first word, only, in bold face type. For *display* ads, using type larger or of a different style than the uniform classified settings, and entirely enclosed with separate rules, rates are as follows:

Single insertion	$16.00 per inch
7 times in 1 year	14.50 per inch
13 times in 1 year	13.00 per inch
26 times in 1 year	11.50 per inch
52 times in 1 year	10.00 per inch

2. **Payment:** For all *classified* ads, payment in advance is required, before insertion can be made. Such advance remittances should be made payable to SCIENCE, and forwarded with advertising "copy" instructions. For *display* advertisers, monthly invoices will be sent on a charge account basis—providing satisfactory credit is established.

3. **Closing Date:** Classified advertisements must be received by SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., together with advance remittance, positively not later than 14 days preceding date of publication (Friday of every week).

For proof service on display ads complete "copy" instructions must reach the publication offices of SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., not later than 4 weeks preceding date of publication.

BOOKS

WANTED — YOUR PERIODICALS —
We need Complete Sets, Runs, Volumes and Single numbers.
CASH IN on your periodical accumulations NOW!
COLLEGE LIBRARY SERVICE • Dept. A, Box 311, N. Y. 3
Also send us your list of wants

Your sets and files of scientific journals
are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. J. S. CANNER AND COMPANY, 909 Boyston Street, Boston 15, Massachusetts. tf

WANTED TO PURCHASE:
SCIENTIFIC PERIODICALS
Sets and runs, foreign and domestic
SCIENTIFIC BOOKS
Entire libraries and smaller collections
WALTER J. JOHNSON
125 East 23rd Street, New York 10, N. Y.

Send us your Lists of tf
SCIENTIFIC BOOKS AND PERIODICALS
which you have for sale.
Complete libraries; sets and runs; and single titles are wanted.
Also please send us your want lists.
STECHERT-HAFNER, INC., 31 East 10th Street, New York 3.

PROFESSIONAL SERVICES

Since 1885
ALBERT TEACHERS AGENCY and COLLEGE BUREAU
25 E. Jackson Blvd., Chicago 4, Ill.
MEMBER NATA
Reliable and Discriminating Service to Colleges and Universities of the Nation and their Personnel.

The Market Place

PROFESSIONAL SERVICES

SPECIAL GLASS APPARATUS
Our glass blowing department is available for special scientific and technical glass apparatus made to specifications and drawings. Inquiries invited. Estimates furnished.
E. MACHLETT & SON
218 East 23rd St. New York 10, N. Y.

AMERICAN COLLEGE BUREAU
28 E. Jackson Blvd.
Chicago 4, Ill.
Universities and Colleges throughout the United States continue their great demand for recommendations for those trained in the different fields of Science. The positions range from instructorships to heads of departments.
•
Our service is nation-wide.

SUPPLIES AND EQUIPMENT

98% Pure . . .
***l* (+) GLUTAMINE**
G & W Laboratories, Inc.
370 Ocean Ave., Jersey City, N. J.

NEW 1950 CATALOG
ON
LABORATORY ANIMAL CAGES & ACCESSORY EQUIPMENT
NOW BEING PRINTED FOR JUNE MAILING—COPY SENT ON REQUEST
HOELTGE BROS., Inc.
1919 Gest St. Cincinnati 4, Ohio

DOUGHERTY CHEMICALS
87-34 134th Street
Richmond Hill 18, N. Y.
Phone: Jamaica 3-1880
IODOACETAMIDE

White SWISS Mice 20c
Write • J. E. STOCKER • Ramsey, N. J.
Rabbits, Cavies, Chickens, Ducks, Pigeons, Hamsters

All Amino Acids (natural, synthetic, unnatural). Rare Sugars, Biochemical Products, Reagents, New Pharmaceuticals in stock. Write or phone PLaza 7-8171 for complete price list.
BIOS LABORATORIES, INC. 17 West 60th Street, New York 23, N. Y.

(The Market Place is continued on next page)

The Market Place

SUPPLIES AND EQUIPMENT

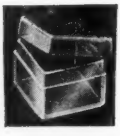
QUARTZWARE

for laboratory and industry
A complete line of standard laboratory ware.
Also custom fabricating to meet your requirements.
For particulars, write: *Quartzware Division*
THE PANRAY CORP.
340 Canal Street, New York 13, N. Y.

PARASITOLOGICAL PREPARATIONS

● high quality — low priced. *Write for catalog*
TROPICAL BIOLOGICALS ● P.O. Box 2227, San Juan, Puerto Rico.

GLYCOCYAMINE—Hydroxyproline, L-Methionine
●AMINO ACIDS ● BIOCHEMICALS
● PRE-MIXED MICROBIOLOGICAL ASSAY MEDIA
H. M. CHEMICAL COMPANY, LTD.
144 North Hayworth Avenue Los Angeles 36, California



TRANSPARENT BOXES

Five Sizes: Maximum protection and visibility for samples, specimens, small parts and other objects easily lost.

Write for leaflet TR-S.
R. P. CARGILLE
116 Liberty St., New York 6, N. Y.

LABORATORY ANIMALS

● Clean healthy well-fed animals
● Guaranteed suitable for your needs.
Reasonably priced—Dependable service

DOGS RATS RABBITS
CATS PIGEONS HAMSTERS
MICE POULTRY GUINEA PIGS
JOHN C. LANDIS • Hagerstown, Md.

now available

β-Glucuronidase

dry powder—stable at room temperature

25,000 Fishman Units per gram* (in ammonium sulfate)

*Fishman, W. H., et al, J. B. C. *173*, 449 (1948)

write for further information

VioBin Laboratories Monticello, Illinois

● HYPOPHYSECTOMIZED RATS

Shipped to all points via Air Express
For further information write
HORMONE ASSAY LABORATORIES, Inc. ● 808 E. 58th St. Chicago 37, Ill.

STAINS
STARKMAN Biological Laboratory
● RARE
● COMMON
Price list on Request
● 461 Bloor St., W. Toronto, Canada

Again Available

MAMMARY TUMORS IN MICE

VIII + 223 pages, 7½ × 10½ inches
double column, illustrated, clothbound
Reproduced, new price $3.50
(to AAAS members $3.00)

This symposium volume of the AAAS has, during the five years since its publication, attracted increased attention. After having been reported out of print for some time, the volume is again available. It contains 12 papers, contributed by members of the National Cancer Institute.

● AAAS SYMPOSIUM and other PUBLICATIONS

7½ × 10½ inches, illustrated, clothbound
(a) indicates cash prices to members.
(b) prices to nonmembers and institutions.

☐ HUMAN MALARIA, 44 papers on history, parasitology, anopheline vectors, epidemiology, symptomatology, pathology and immunity, treatment, control and eradication; reprinted. 406 pp. (a) $4.00, (b) $5.00.

☐ LIEBIG and AFTER LIEBIG—A Century of Progress in Agricultural Chemistry. 10 papers make available in convenient form the history of one of the most significant developments in agricultural science. 119 pp. (a) $2.50, (b) $3.00.

☐ RELAPSING FEVER in the AMERICAS, 20 papers on symptomatology, diagnosis, etiology, epidemiology, pathology and immunity, tick vectors, treatment and public health aspects. 136 pp. (a) $2.50, (b) $3.00.

☐ DENTAL CARIES and FLUORINE, 11 papers report on investigations in the British Isles, India, South Africa and the U.S.A. 111 pp. (a) $3.00, (b) 3.50.

☐ APPROACHES to TUMOR CHEMOTHERAPY, 41 papers. A progress report addressed largely to future workers. 412 pp. (a) $6.50, (b) $7.75.

☐ RICKETTSIAL DISEASES of MAN, 27 papers record the control of Rickettsial diseases during World War II and reveal the scientific foundation on which the adopted methods rest. 255 pp. (a) $5.25, (b) $6.25.

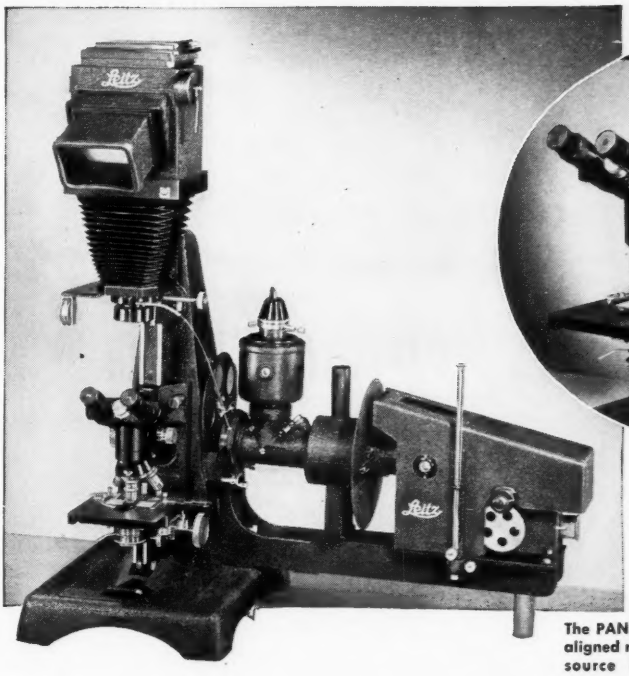
☐ LIMNOLOGICAL ASPECTS of WATER SUPPLY and WASTE DISPOSAL (6 x 9), 8 papers sample the border area within the scope of interests common to the engineer, the limnologist, and the oceanographer. 93 pp. (a) $2.75, (b) $3.25.

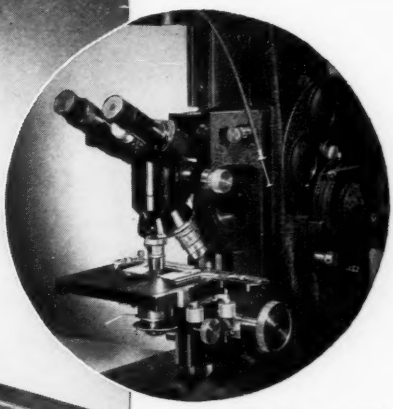
☐ AAAS PROCEEDINGS and DIRECTORY of MEMBERS
1940–1948, 6 × 9 inches, 1219 pp.
(a) $8.50, (b) $9.50

A.A.A.S. PUBLICATIONS
1515 Massachusetts Ave., N.W.
Washington 5, D. C.

Please accept my order for one copy of *Mammary Tumors in Mice* and for the volumes checked above. My check in the amount of $.....is enclosed.

NAME .....
ADDRESS .....
CITY .....
ZONE ..... STATE .....





Large stage moves up and down for finer, faster focusing.

The PANPHOT combines permanently aligned microscope, camera and light source in one convenient unit.

The Leitz Panphot

Universal Camera Microscope

Only the Leitz PANPHOT enables you to switch from microscopic observation to photo-micrography *without moving from your chair.* Change-over from one to the other is fast, simple, dependable.

Now available to biological and clinical laboratories, the PANPHOT is a perfect combination of research microscope and reflex camera. The PANPHOT permits the use of any type of illumination—transmitted light, reflected light, darkfield illumination and polarized light. The camera accommodates 3¼″ x 4¼″ plates or cut film for black and white or color work.

A full range of accessories is available to equip the PANPHOT for every phase of photo-micrography, photo-macrography and for drawing and projecting micro-images.

Write today for information to Dept. SC

E. LEITZ, Inc., 304 Hudson Street, New York 13, N. Y.

LEITZ MICROSCOPES • SCIENTIFIC INSTRUMENTS • LEICA CAMERAS AND ACCESSORIES

NEW!

NOW EVERYONE CAN ENJOY THE 'LAST WORD' IN COLORSLIDE PROJECTION

AO PERFORMER 150

Delineascope

Discriminating amateurs and professionals, enthusiastic in their praise of the MC Delineascope, brought about the demand for this 150-watt 2″ x 2″ color slide projector to meet the needs and pocketbook of the average home user.

The new PERFORMER 150 offers . . . aspheric condensers . . . heat-absorbing glass . . . 5″ focus f/3.75 Americoted objective, *achromatically—anastigmatically balanced . . . true color* projection . . . fast, positive elevating lever . . . Autofocus slide carrier . . . cool double lamp house . . . sturdy metal construction.

Ask your photographic dealer to show you the new AO PERFORMER 150 Delineascope.

$42.90 (attractive lift-off carrying case $6.90 extra)

American Optical COMPANY

INSTRUMENT DIVISION • BUFFALO 15, NEW YORK